AWARD NUMBER: W81XWH-12-2-0121

TITLE: Project VALOR: Trajectories of Change in PTSD in Combat-Exposed Veterans

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REPORT DATE: October 2017

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Materiel Command
                Fort Detrick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Approved for Public Release;
                        Distribution Unlimited

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
October 2017	Annual	30Sep2016 - 29Sep2017

4. TITLE AND SUBTITLE

Project VALOR: Trajectories of Change in PTSD in Combat-Exposed Veterans

5a. CONTRACT NUMBER

5b. GRANT NUMBER
W81XWH-12-2-0121

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

New England Research Institutes,
Inc.
480 Pleasant St.
Watertown, MA 02472

8. PERFORMING ORGANIZATION REPORT

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for Public Release; Distribution Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This goal of this project is to develop a large-scale, longitudinal registry of PTSD in combat-exposed OIF/OEF/OND male and female veterans. The objective of the current study is to systematically expand the longitudinal assessment by collecting follow-up data at additional time points for multiple domains of interest. Patterns of longitudinal change in the VALOR cohort will be empirically classified into trajectory subtypes by means of latent growth mixture modeling. The availability of comprehensive data on PTSD symptoms and related exposures and outcomes at multiple time points in a cohort of VA users with and without PTSD provide a unique opportunity to examine a number of hypotheses regarding longitudinal trajectories in combat-exposed veterans. In addition, the large proportion of women in our sample will allow us to examine variation in the associations by gender.

15. SUBJECT TERMS
Risk factors for PTSD, PTSD symptom development, VA healthcare utilization.

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON: USAMRMC
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**	Unclassified	76	**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified			

Table of Contents

1. **INTRODUCTION:**

Project VALOR is a large-scale, longitudinal registry of PTSD in combat-exposed OIF/OEF/OND male and female veterans. The objective of the current study is to systematically expand the longitudinal assessment by collecting follow-up data at additional time points for multiple domains of interest. Patterns of longitudinal change in the VALOR cohort will be empirically classified into trajectory subtypes by means of latent growth mixture modeling. The availability of comprehensive data on PTSD symptoms, related exposures, and outcomes at multiple time points in a cohort of VA users with and without PTSD provides a unique opportunity to examine a number of hypotheses regarding longitudinal trajectories in combat-exposed veterans. In addition, the large proportion of women in our sample will allow us to examine variation in the associations by gender.

Using baseline and follow-up data from participants in Project VALOR, we will evaluate the following specific aims:

1. Examine trajectories of PTSD symptomatology and diagnosis by chart and diagnostic interview assessments in combat-exposed men and women.

2. Examine the nature and extent of military sexual trauma (MST) in combat-exposed men and women who have utilized the VA Healthcare System, including the contribution of MST to PTSD symptoms and diagnosis.

3. Examine associations of PTSD, mTBI, major depressive disorder (MDD), and treatment utilization in relation to changes in suicidal ideation.

2. **KEYWORDS:**

Post-traumatic stress disorder (PTSD), military sexual trauma (MST), suicide, combat-exposed veterans, PTSD trajectory, longitudinal, VA treatment utilization

3. **OVERALL PROJECT SUMMARY:**

In quarter one of this year, 1544 participants were consented to participate in the study and 1201 had completed their participation in the third phase (consisting of an online questionnaire and telephone interview). In accordance with the approved statement of work (SOW), by the end of quarter two we concluded subject recruitment and data collection this for the third time point of this grant. Specifically, we completed all elements of Task 7 listed in the SOW, including: reminding participants to complete follow-up questionnaires, verifying completion of online questionnaires, scheduling and conducting diagnostic telephone interviews, and mailing payment and reconfirming contact information. In the second quarter we accomplished Milestone #8 listed in the SOW, having completed the second round of follow-up diagnostic telephone interviews. While clinical interviews were underway, assessors attended weekly reliability meetings in which they review a sample of completed interviews for quality assurance. A total of 1202 subjects completed this phase, representing 72.9% of the original Project VALOR sample (n=1649).

Additionally, we completed a majority of the items associated with Task 8 in the SOW (Continued Abstraction of Medical Records). Specifically, we have updated data on variables of interest for all current participants (8.a), screened data for accuracy and consistency (8.b), merged data with other datasets (8.d), and de-identified data (8.e). We have computed a number of variables of interest from EMR data and continue this process currently (8.c).

In the third and fourth quarters we began work consistent with Task 11 (Conduct Analyses of Longitudinal Data). Specifically, we have begun to conduct preliminary statistical analyses to address the proposed Specific Aims and examine trajectories of change in PTSD (11.a). During the third and fourth quarters, we also began working on Task 12. Through working with NIMH, we have determined where the final database will be stored as well as completed all the necessary codebooks for each of our 4 time points.

Interim analyses are ongoing. To date, a number of projects which are in line with study aims have been presented to an international audience at a range of conferences. Each of these projects has involved a combination of data collected via self-report, interview, and/or the EMR.

While preparing the final dataset to address our first aim of examining the trajectories of PTSD symptomatology and diagnosis, we have conducted additional interim analyses to better understand how PTSD affects other outcomes across time. For example, our interim analyses have provided insight into factors that influence treatment utilization behaviors of OEF/OIF Veterans; the longitudinal association between PTSD and metabolic syndrome; and how Veterans with unique presentations of PTSD (e.g., dissociative subtype) differ from those with a more traditional diagnosis.

Our second aim is to examine the nature and extent of military sexual trauma (MST) in combat-exposed men and women who have utilized the VA Healthcare System, including the contribution of MST to PTSD symptoms and diagnosis. We have made excellent progress on this goal in our interim analyses, finding and presenting research which investigated the utility of repeated screening for MST; associations between childhood sexual trauma and the dissociative subtype of PTSD; as well as the prevalence of PTSD and depression for sexual minority and non-sexual minority female veterans exposed to MST.

Through interim analyses, we have also made progress on our third aim, which is to examine associations of PTSD, mTBI, major depressive disorder (MDD), and treatment utilization in relation to changes in suicidal ideation. We have presented the results of our findings at various conferences. These results provide information about potential risk factors for suicidal behaviors (which include peritraumatic emotion and trauma type); post deployment social support as a key protective factor for suicide risk; and the effectiveness of VA safety plans in reducing risk of suicidality. The presentations associated with the interim analyses for all three aims are listed in section 6 of this document.

We are also beginning to formulate research questions beyond those proposed in the initial aims of the project, and we are planning to conduct analyses and to present the results of these in future presentations and publications. Our last scientific advisory board meeting (SAB) was held in December of 2016. Since then, the team has been in regular contact with key members of the advisory board who have been briefed on interim research findings. The next meeting will be scheduled shortly and will take place in November or December 2017.

4. **KEY RESEARCH ACCOMPLISHMENTS:**
   Nothing to report

5. **CONCLUSION:**
   The PTSD registry will provide information to assist researchers, military leaders, and treatment providers to better understand PTSD and related problems, with a specific focus on the course of the disease, suicidal ideation, and military sexual trauma. This knowledge will be of benefit to health care providers, policy makers and current service members as well as victims of trauma in the broader community. It will include:
   • Evaluation of long-term outcomes of PTSD;
   • A more accurate assessment of current theoretical models of symptom development, and;
   • Documentation of health resource utilization and development of a database that will serve as a resource for health services planning and policy.

   Furthermore, this study will contribute:
   • The formation of a potential cohort of subjects for ancillary studies, ranging from genomic influences to quality of life and psychosocial outcomes, as well as future clinical trials;
   • The creation of a representative sample of PTSD OEF/OIF/OND Veterans who use the VA medical system available for use in epidemiologic studies, particularly for comparisons with active duty and other Veteran or civilian populations;
   • Utility to clinicians, patient advocacy groups, and health policy planners;
   • Publications and dissemination of the registry results to provide a representative perspective of what is achieved in actual current care settings, thereby augmenting outcomes data from clinical trials.

6. **PUBLICATIONS, ABSTRACTS, AND PRESENTATIONS:**

   PUBLICATIONS

Engel-Rebitzer, E., Bovin, M. J., Black, S. K., Rosen, R. C., Keane, T. M., & Marx, B. P. (2017). A longitudinal examination of peritraumatic emotional responses and their association with posttraumatic stress disorder and major depressive disorder among veterans. *Journal of Trauma & Dissociation*, 18(5), 679-692. doi: 10.1080/15299732.2016.1267683.

Green, J.D., Annunziata, A., Kleiman, S.E., Bovin, M.J, Harwell, A.M, Fox, A.M.L, Black, S.K., Schnurr, P.P., Holowka, D.W., Rosen, R.C., Keane, T.M., Marx, B.

(2017). Examining the diagnostic utility of the DSM-5 PTSD symptoms among male and female returning veterans. *Depression and Anxiety, 34*(8), 752-760. doi: 10.1002/da.22667.

Jackson, C. E., Green, J. D., Bovin, M. J., Vasterling, J. J., Holowka, D. W., Ranganathan, G., & Rosen, R. C., Keane, T. M., Marx, B. P. (2016). Mild traumatic brain injury, PTSD, and psychosocial functioning among male and female U.S. OEF/OIF veterans. *Journal Of Traumatic Stress, 29*(4), 309-316. doi:10.1002/jts.22110

Kearns, J. C., Gorman, K. R., Bovin, M. J., Green, J. D., Rosen, R. C., Keane, T. M., & Marx, B. P. (2016). The effect of military sexual assault, combat exposure, postbattle experiences, and general harassment on the development of PTSD and MDD in Female OEF/OIF veterans. *Translational Issues In Psychological Science*, *2*(4), 418-428. doi:10.1037/tps0000098

Marx, B. P., Engel-Rebitzer, E., Bovin, M. J., Parker-Guilbert, K. S., Moshier, S., Barretto, K., Szafranski, D., Gallagher, M. W., Holowka, D. W., Rosen, R. C., & Keane, T. M. & Keane, T. M. (2017). The influence of veteran race and psychometric testing on veterans affairs posttraumatic stress disorder (PTSD) disability exam outcomes. *Psychological Assessment*, *29*(6), 710.

Mitchell, K. S., Wolf, E. J., Bovin, M. J., Lee, L. O., Green, J. D., Rosen, R. C., Keane, T. M., & Marx, B. P. (2017). Network models of DSM–5 posttraumatic stress disorder: Implications for ICD–11. *Journal Of Abnormal Psychology, 126*(3), 355-366. doi:10.1037/abn0000252

PRESENTATIONS

Black, S.K., Harwell, A.M., Klein, A.B., Bovin, M.J., Green, J.D., Keane, T.M. Rosen, R.C., & Marx, B.P. (October 2016). Implications of the Recent and Upcoming Diagnostic Changes to Posttraumatic Stress Disorder: A Comparison of DSM-5 and ICD-11. Poster presented at the Association for Behavioral and Cognitive Therapy 50th Annual Meeting. New York, NY.

Bovin, M. J., Black, S. K., Rodriguez, P., Lunney, C. A., Weathers, F. W., Schnurr, P. P., Keane, T. M., & Marx, B. P. (November, 2016). The Inventory of Psychosocial Functioning (IPF): Development and utility of a measure of PTSD-specific impairment. Paper presented as part of a symposium (Examining the impact of PTSD on work, family, and other related quality of life outcomes in veterans of the wars in Iraq and Afghanistan; Chair: B. Smith) at the International Society for Traumatic Stress Studies 32nd Annual Meeting. Dallas, TX

Brown, M. E., Klein, A. B., Harwell, A. M., Pedersen, S. R., Lee, D. J., Bovin, M. J., Rosen, R. C., Keane, T. M., & Marx, B. P. (June, 2017). Childhood abuse as a predictor of military sexual trauma. Paper presented as part of a symposium (ISTSS: Child Maltreatment; Chair: G. S. Hafstad) at the European Society for Traumatic Stress Studies 15th Annual Meeting. Odense, Denmark.

Brown, M.E., Pedersen, S.R., Green, J.D., Kearns, J.C., Rosen, R.C., Keane, T.M. & Marx, B.P. (August, 2017). Suicide Prevention & Treatment - Evaluating the Effectiveness of Safety Plans for Military Veterans: Do Safety Plans Tailored to Veteran Characteristics Decrease Suicide Risk? Poster session presented at 2017 Military Health System Research Symposium (MHSRS), Kissimmee, FL.

Gorman, K.R., Klein, A.B., Kearns, J.C., Parker-Guilbert, K.S., Bovin, M.J., Rosen, R.C., Keane, T.M. & Marx, B.P. (October, 2016). Comparison of PTSD and depression in sexual minority and non-sexual minority female veterans exposed to military sexual assault, combat, and harassment. Poster presented at the 50th annual meeting of the Association for Behavioral and Cognitive Therapies. New York, NY.

Green, J.D., Kearns, J.C., Marx, B.P., Nock, M.K., Rosen, R.C., & Keane, T.M. (October, 2016). Evaluating safety plan effectiveness: do safety plans tailored to individual veteran characteristics decrease risk? Paper presented as part of a symposium (Preventing suicide among military and veteran populations; Chair: D. Lee) at the 50th annual meeting of the Association for Behavioral and Cognitive Therapies. New York, NY.

Green, J.D., Marx, B.P., Rosen, R.C., & Keane, T.K. (April, 2017). Mental Health Utilization in OIF/OEF Veterans with PTSD: The Role of Diagnostic Accuracy and Service Connection as Determinants of Care Seeking. Paper presented as part of a symposium (PTSD Treatment among Military Service Members and Veterans: Determinants of Service Utilization and Outcome; Chair: T. Keane & R. Rosen) at the Anxiety and Depression Association of America 37th Annual Conference. San Francisco, CA.

Harwell, A. M., Klein, A.B., Erb, S. E., Green, J.D, Holowka, D.W., Bovin, M.J., Marx, B. P., Keane, T. M, & Rosen, R. C. (October, 2016). Wartime atrocity exposure and PTSD symptom severity among OEF/OIF veterans: Evaluating the role of gender. Poster accepted for presentation at the annual meeting of the Association for Behavioral and Cognitive Therapies (ABCT), New York, NY.

Harwell, A. M., Moshier, S.J., Klein, A.B., Rosen, R. C., Keane, T. M., & Marx, B. P. (November, 2016). Wartime atrocity exposure type, PTSD diagnosis and symptom severity prediction among OEF/OIF Veterans. Poster accepted for presentation at the 32nd annual meeting of the International Society for Traumatic Stress Studies, Dallas, TX.

Klein, A.B., Bovin, M.J., Brown, M.E. Rosen, R.C., Keane, T.M., & Marx, B.P. (April, 2017). Associations Among Dimensions of Childhood Adversity and Internalizing and Externalizing Symptoms in a Sample of OEF/OIF Veterans. Presented at the 37th annual Anxiety and Depression Association of America, San Francisco, CA.

Klein, A.B., Green, J.D., Gorman, K.R., Bovin, M.J., Rosen, R.C., Keane, T.M. & Marx, B.P. (October 2016). Associations between childhood trauma and the dissociative subtype of PTSD in OEF/OIF veterans. Poster presented at the 50th annual meeting of the Association for Behavioral and Cognitive Therapies, New York, NY.

Klein, A.B., Moshier, S.J., Harwell, A.M., Rosen, R.C., Keane, T.M. & Marx, B.P. (November, 2016). Associations between treatment satisfaction and one-year clinical outcomes in OEF/OIF veterans with PTSD. Poster presented at the

32nd annual meeting of the International Society for Traumatic Stress Studies, Dallas, TX.

Liang, J. J., Romano, A. S., Klein, A., Harwell, A., Bovin, M. J., Green, J. D., Marx, B. P., & Rasmusson, A. M. (November 2016). VALOR investigation of reproductive/ gynecological health problems among deployed women veterans exposed to military sexual trauma. Poster presented at the Joining Forces Conference. Boston, MA.

Marx, B. P., Bovin, M. J., Lee, D., Parker-Guilbert, K., Rosen, R. C., & Keane, T. M. (November 2016). Examining the longitudinal associations among functional impairment, quality of life outcomes, and PTSD status with OEF/OIF veterans. Paper presented as part of a symposium (Factors influencing long-term functional recovery among warzone-deployed service members; Chair: S. Morissette) at the International Society for Traumatic Stress Studies 32nd Annual Meeting. Dallas, TX.

Mitchell, K. S., Wolf, E. J., Bovin, M. J., Lee, L., Green, J. D., Rosen, R. C., Keane, T. M., & Marx, B. P. (November 2016). Network models of DSM-5 posttraumatic stress disorder: Implications for ICD-11. Paper presented at the International Society for Traumatic Stress Studies 32nd Annual Meeting. Dallas, TX.

Moshier, S.J., Erb, S., Parker-Guilbert, K., Trachtenberg, F., Rosen, R.C., Keane, T.M., & Marx B.P. (November, 2016). Less symptomatic but more impaired: Correlates of early treatment termination among returning veterans with PTSD. Poster presented at the International Society for Traumatic Stress Studies 32nd Annual Meeting. Dallas, TX.

Moshier, S.J., Klein, A.B., Kleiman, S., Parker-Guilbert, K., Harwell, A.M., Trachtenberg, F., Rosen, R.C., Keane, T.M., & Marx, B.P. (2017, April). Treatment satisfaction and early termination in US veterans seeking treatment for PTSD. Presented in A. Asnaani (Chair), From RCTs to the clinic: Predictors, moderators, and other factors influencing naturalistic CBT outcomes for populations with anxiety disorders. Symposium at the Anxiety and Depression Association of America 37th Annual Conference, San Francisco, CA.

Pedersen, S.R., Bovin, M.J., Klein, A.B., Jackson, C.E., Green, J.D., Harwell, A.H., Rosen, R.C., Keane, T.M., Marx, B.P. (May 2017). The influence of veteran gender on applying for and receiving TBI-related service connection. Poster presented at the Association for Psychological Science (APS) Annual Convention, Boston, MA.

Pedersen, S., Brown, M., Moshier, S.J., Kleiman, S.E., Seal, K., Trachtenberg, F., Rosen, R.C., Keane, T.M., Marx, B.P. (August, 2017). Complementary and integrative health strategies: Use and interest in a sample of veterans with PTSD. Poster presented at the Military Health System Research Symposium (MHSRS). Kissimmee, FL.

Rosen, RC., Green, J.D., Bovin, M.J., Kleiman, S.K., Moshier, S.J., Magnavita, A., Rangnathan, G., Trachtenberg, F., Marx, B.P., & Keane, T.M. (August, 2017). Optimizing enrollment, retention and successful data collection in large,

observational studies in military populations: The Project VALOR experience. Poster presented at the Military Health System Research Symposium (MHSRS). Kissimmee, FL.

7. **INVENTIONS, PATENTS AND LICENSES:**
Nothing to report

8. **REPORTABLE OUTCOMES:**

Engel-Rebitzer and colleagues (2016) examined the longitudinal relationship between seven peritraumatic (occurring during or immediately following trauma) emotional responses and the development of posttraumatic stress disorder (PTSD) and major depressive disorder (MDD) in the Project VALOR sample. Cross-sectional analyses revealed associations between retrospective endorsement of peritraumatic numbness, anger, and horror and concurrent PTSD diagnosis. Only peritraumatic numbness was associated with concurrent MDD diagnosis. Longitudinal analyses revealed that only retrospective endorsement of peritraumatic numbness was associated with PTSD and MDD diagnoses at time point 2. These results are the first to address peritraumatic emotional response associations with PTSD and MDD longitudinally while controlling for baseline PTSD and MDD. The above detailed paper is attached for reference.

Green and colleagues (2017) examined the diagnostic utility of each of the DSM-5 posttraumatic stress disorder (PTSD) symptoms in male and female veterans. This research addressed concerns that DSM-5 PTSD diagnostic criteria include symptoms that overlap with comorbid disorders, thus inflating comorbidity rates and reducing diagnostic validity. 1,347 Project VALOR participants were assessed by doctoral level participants using the PTSD module of the Structured Clinical Interview for DSM-5. Of the 20 symptoms considered, the majority were in the fair to poor range on test quality indices. The subset of symptoms outlined in the 11th edition of the International Classification of Diseases (ICD-11) performed no better in diagnostic specificity nor in rates of comorbidity than the DSM-5 criteria. These results suggest that developing new diagnostic criteria may be valuable, but the alterations made in the ICD-11 are not an improvement. The above detailed paper is attached for reference.

Jackson and colleagues (2016) examined the relationship between mild traumatic brain injury (mTBI) and PTSD and psychosocial functioning in 1,312 Project VALOR male and female veterans. PTSD was measured using the SCID-IV PTSD module while mTBI was assessed by a series of structured questions based on current TBI classification standards from the American Congress of Rehabilitation Medicine Head Injury Interdisciplinary Special Interest Group, the VA, and the U.S. Department of Defense. Psychosocial functioning was measured using the Inventory of Psychosocial Functioning. Individuals with PTSD, as measured by the SCID-IV PTSD module, reported significantly worse psychosocial functioning than those with mTBI alone or neither PTSD nor mTBI, (males, $\eta^2_p = .11$, $p < .001$; females, $\eta^2_p = .14$, $p < .001$). These results suggest

that PTSD diagnosis may be uniquely associated with worse psychosocial functioning. The above detailed paper is attached for reference.

Kearns and colleagues (2016) examined the associations between military sexual assault (MSA) and both PTSD and major depressive disorder (MDD) diagnostic status and symptom severity in female OEF/OIF veterans. Participants were 673 female Project VALOR participants who were assessed by a doctoral level clinician with the SCID-5 modules for PTSD and MDD. Participants also completed self-report measures of MSA, combat exposure, postbattle experiences, general harassment, and PTSD and depression symptom severity. After controlling for demographics, combat exposure was the sole significant predictor of PTSD diagnosis (AOR = 1.07) while MSA was the sole significant predictor of MDD diagnosis (AOR = 1.30). PTSD symptom severity was predicted by combat exposure (**β =** .26) and general harassment (**β =** .15). MDD symptom severity was predicted by MSA (**β =** .16), combat exposure (**β =** .20) and general harassment (**β =** .16). These results suggest that MSA, combat exposure and general harassment are three valuable predictors of psychopathology in veteran women. The above detailed paper is attached for reference

Marx and colleagues (2017) examined the influence of veterans' race and examiners' use of psychometric testing during a Department of Veterans Affairs posttraumatic stress disorder (PTSD) disability examination on diagnostic and service connection status outcomes. Current and lifetime PTSD diagnostic status were determined with the Structured Clinical Interview for DSM-IV (SCID) and were compared with PTSD diagnosis conferred upon veterans by their compensation and pension (C&P) examiners as well as with ultimate Veterans Affairs (VA) PTSD service connected (SC) status. The concordance rate between independent SCID PTSD diagnosis and PTSD disability examination diagnosis was 70.4% when utilizing the current version of the SCID and was 77.7% when utilizing the lifetime version of the SCID. Among veterans with current SCID diagnosed PTSD, Black veterans were significantly less likely than White veterans to receive a PTSD diagnosis from their C&P examiner (*OR* = .39, *p* = .003, CI = .20-.73). Among veterans without current SCID diagnosed PTSD, White veterans were significantly more likely than Black veterans to receive a PTSD diagnosis from their C&P examiner (*OR* = 4.07, *p* = .005, CI = 1.51-10.92). Splitting the sample by use of psychometric testing revealed that disability examinations that did not include psychometric testing demonstrated the same relationship between veteran race and diagnostic concordance. However, for examinations in which psychometric testing was used, the racial disparity between SCID PTSD status and disability exam PTSD status was no longer significant. Results suggest that psychometric testing may reduce disparities in VA PTSD disability exam outcomes. The above detailed paper is attached for reference.

Mitchell and colleagues (2016) performed network analyses of DSM-5 symptoms of PTSD in order to evaluate the performance of the proposed six-symptom criteria for ICD-11 and in order to understand which symptoms of PTSD may be most central (i.e., influential) to the PTSD symptom network. The sample consisted of 1,458 Project VALOR participants who had completed the DSM-5

PTSD Checklist. In this sample, six symptoms were identified as central to the disorder: persistent negative emotional state, efforts to avoid external reminders, efforts to avoid thoughts or memories, inability to experience positive emotions, distressing dreams, and intrusive distressing thoughts or memories. Notably, the ICD-11's reduced criteria include only three of these symptoms (out of the overall six criteria included). However, an empirically defined index of the six most central PTSD symptoms as defined in these network analyses performed comparably to an index representing the ICD-11 criteria at predicting a DSM-5 PTSD diagnosis in participants. The above detailed paper is attached for reference.

9. **OTHER ACHIEVEMENTS:**
   Nothing to report

10. **REFERENCES**
    N/A

11. **APPENDICES**
    Attached

Routledge
Taylor & Francis Group

ARTICLES

A longitudinal examination of peritraumatic emotional responses and their association with posttraumatic stress disorder and major depressive disorder among veterans

Eden Engel-Rebitzer, BA[a], Michelle J. Bovin, PhD[a,b], Shimrit K. Black, PhD[b], Raymond C. Rosen, PhD[c], Terence M. Keane, PhD[a,b], and Brian P. Marx, PhD[a,b]

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ABSTRACT

Research has revealed a significant association between several peritraumatic emotional responses and posttraumatic stress disorder (PTSD). Preliminary research has also linked peritraumatic emotional responses with a diagnosis of major depressive disorder (MDD). The majority of this research has been cross-sectional, thereby making it difficult to determine the extent to which the various peritraumatic emotional responses may increase risk for, or serve as a premorbid marker of, PTSD and MDD. This study examined the longitudinal role of peritraumatic emotional responses on the subsequent development of PTSD and MDD in a sample of US military veterans. Whereas a number of peritraumatic emotional responses were concurrently associated with PTSD, only peritraumatic numbness maintained the association with this diagnosis longitudinally. For MDD, peritraumatic numbness was the only emotional response related to the diagnosis both concurrently and longitudinally. Study findings are a preliminary proof of concept that peritraumatic numbness may serve as a premorbid marker for the development of PTSD and MDD following a traumatic event. Implications of these findings for the diagnosis, assessment, and treatment of both PTSD and MDD are discussed.

Prior research has identified a significant association between several peritraumatic emotional responses (i.e., emotional reactions experienced during or immediately following a traumatic event) and posttraumatic stress disorder (PTSD; for a meta-analytic review see Ozer, Best, Lipsey, & Weiss, 2008). These peritraumatic emotional responses include those previously featured in PTSD Criterion A2 (i.e., fear, helplessness, and horror) of the fourth edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV; APA, 2000) as well as others including disgust, sadness, and anger (Bovin & Marx, 2011; Breslau & Kessler, 2001; Brewin, Andrews, & Rose, 2000; Creamer, McFarlane, & Burgess, 2005; Engelhard,

Olatunji, & de Jong, 2011; Hathaway, Boals, & Banks, 2010; Kilpatrick et al., 1998). In addition, previous studies with veterans and service members have revealed a significant association between peritraumatic emotional numbing and PTSD (Epstein, Fullerton, & Ursano, 1998; Roemer, Orsillo, Borkovec, & Litz, 1998).

Notably, the majority of this past work is cross-sectional, simultaneously assessing retrospective peritraumatic emotional responses and current symptoms, thereby making it difficult to determine the extent to which the various peritraumatic emotional responses may serve as a premorbid marker of PTSD. Of the few studies that have examined these associations longitudinally, two did not control for baseline PTSD symptoms in their analyses (Brewin et al., 2000; O'Donnell et al., 2008), one collapsed longitudinal data across time points (Epstein et al., 1998), and one found significant cross-sectional, but not longitudinal, associations (Engelhard et al., 2011). Thus, although it has long been surmised that peritraumatic emotional responses may predict subsequent PTSD, conclusive evidence is lacking.

Although the existing research on peritraumatic emotional responses has focused on PTSD, there is reason to suspect that these responses may also be related to major depressive disorder (MDD). PTSD and MDD often co-occur following exposure to a traumatic event (Keane, Taylor, & Penk, 1997; O'Donnell, Creamer, & Pattison, 2004) and may be a part of the same general traumatic stress construct (O'Donnell et al., 2004). Further, research shows that a variety of environmental stressors (e.g., childhood abuse and neglect, rape) and individual difference factors (e.g., gender and trait neuroticism) confer risk of both PTSD and MDD (e.g., Breslau, Davis, Andreski, Peterson, & Schultz, 1997; Carlson & Rosser-Hogan, 1991; Kendler, Gardner, & Prescott, 2002; Miller, Kaloupek, Dillon, & Keane, 2004; Rosendal, Şalcıoğlu, Andersen, & Mortensen, 2011). In addition, there is some evidence that several peritraumatic emotions (e.g., fear, sadness, anger, disgust) are associated with MDD (Miguel-Tobal et al., 2006; Rizvi, Kaysen, Gutner, Griffin, & Resick, 2008). However, similar to PTSD, most of these studies have been cross-sectional, making it unclear whether peritraumatic emotional responses are a marker for subsequent MDD. In the only longitudinal investigation to date, peritraumatic fear, helplessness, and horror longitudinally predicted MDD at 12 months after excluding participants who met criteria for MDD at the initial time point; however, only these three peritraumatic emotions were examined (O'Donnell et al., 2008). Given that cross-sectional research has found associations between peritraumatic emotions other than fear, helplessness, and horror and MDD, additional research is needed to determine whether there is also a longitudinal relationship between these other peritraumatic emotional responses and MDD.

Understanding the longitudinal relationship between a range of peritraumatic emotions and PTSD and MDD is important because these findings may assist us in identifying individuals that are at greater risk of developing psychopathology following a trauma. The current study addresses the aforementioned gaps in the

literature by examining the concurrent and longitudinal associations among a range of peritraumatic emotional responses (fear, helplessness, horror, disgust, sadness, anger, and numbing) and both PTSD and MDD in a sample of veterans who served in Operation Iraqi Freedom (OIF), Operation Enduring Freedom (OEF), and/or Operation New Dawn (OND), while controlling for baseline PTSD and MDD. Consistent with previous research, we predicted that each of these peritraumatic emotional responses would be significantly associated with concurrent PTSD and MDD. Given the unsettled nature of the existing longitudinal research, we had no specific hypotheses regarding the association between peritraumatic emotional responses and subsequent PTSD and MDD diagnostic status longitudinally.

Method

Participants and procedure

Participants included US Army and Marine Corps veterans enrolled in the Veterans After-Discharge Longitudinal Registry (Project VALOR) between 2009 and 2012 (Rosen et al., 2012). Eligibility requirements for Project VALOR included either separation from active duty after serving in OIF/OEF/OND or completion of at least one Reserve/National Guard deployment in support of OIF/OEF/OND. Veterans were also required to have undergone a mental health evaluation at a VA facility, indicated by a diagnostic interview or psychotherapy procedure code between July 2008 and December 2009, and could not be participating in a clinical trial at the time of enrollment. Veterans with probable PTSD were oversampled at a 3:1 ratio for the purpose of the larger study. Female veterans were oversampled at a 1:1 ratio to allow for the examination of gender differences in Project VALOR.

Veterans meeting the aforementioned inclusion criteria were contacted via telephone by study staff to inquire about interest in study participation (N = 4,391). Of those contacted, 2,712 (61.8%) provided informed consent to participate verbally over the telephone following an explanation of study procedures. Following their consent, participants were scheduled for a diagnostic interview and were asked to complete self-administered questionnaires (either online or by mail). One thousand six hundred and forty-nine OIF/OEF/OND veterans completed these procedures at the Time 1 (T1; baseline) assessment for Project VALOR. Approximately two years later, all T1 participants were re-contacted and asked to complete a follow-up online questionnaire and telephone interview (Time 2; T2). One thousand three hundred and seventy-nine participants completed the questionnaires at T2, and 1347 completed both the questionnaires and the interview at T2. Participants were compensated $50 for their T1 participation and $100 for their T2

participation. The research protocol was approved by all local Institutional Review Boards and the Human Research Protection Office of the US Army Medical Research and Materiel Command.

In the present analyses, all Project VALOR participants with comorbid PTSD and MDD at Time 1 (n = 452) were excluded in order to allow for an examination of how the peritraumatic emotions affect each diagnosis individually. Participants with comorbid PTSD and MDD did not differ from participants without comorbid PTSD and MDD on age, the time between the index event at T1 assessment, or the time between T1 and T2 assessments (all ts < 1.94; all ps > .05). Similarly, there was no difference between groups on gender (χ^2 = 1.17; p = .28). However, participants with comorbid PTSD and MDD did differ from participants without this comorbidity on education (χ^2 = 30.54; p < .01); participants with comorbid PTSD and MDD were more likely to have received a vocational/technical degree (std. resd. = 2.1) and less likely to have received a college degree (std. resd. = −2.4) than participants without this comorbidity. Although the omnibus test indicated a difference between groups on ethnicity (χ^2 = 6.42; p < .05), none of the post hoc tests were significant (all std. resd. < 1.96).

The remaining sample (n = 927) was divided into two groups: those with no MDD at T1 (regardless of PTSD status; the PTSD group; n = 823) and those with no PTSD at T1 (regardless of MDD status; the MDD group; n = 522). Thus, each group was allowed to vary on the diagnosis of interest (e.g., participants in the PTSD group may or may not have had a PTSD diagnosis at T1) as long as they did not meet criteria for the other diagnosis at T1 (e.g., no participants in the PTSD group met criteria for MDD at T1). Participants who did not meet criteria for either MDD or PTSD at T1 (n = 418) were included in both sets of analyses.

An additional 237 participants from the PTSD group and 188 participants from the MDD group were excluded due to missing data on key variables. Participants excluded from the PTSD group did not differ from those included in the PTSD group (n = 586) on age (t = −1.76; p = .08), educational status, gender, or ethnicity (all χ^2s < 13.04; all ps > .05). However, excluded participants did have significantly more time since the trauma and time between the T1 and T2 assessments than participants who were included in the PTSD group (ts > 7.08; all ps < .01). Similarly, participants excluded from the MDD group did not differ from those included in the MDD group (n = 334) on age (t = 0.39; p = .69), educational status, gender, or ethnicity (all χ^2s < 5.47; all ps > .05). However, excluded participants did have significantly more time since the trauma and more time between the T1 and T2 assessments than participants who were included in the MDD group (ts > 4.92; all ps < .05).

Measures

The following battery of self-report questionnaires and interviews was examined in the current study:

Demographics

Age, race, gender, and highest educational degree were assessed via self-report measures at T1.

Peritraumatic emotional responses

The Measure of Emotional Responses to Trauma (MERT; Bovin et al., 2012) is a 19-item interviewer-administered measure developed to assess the occurrence of peritraumatic emotional responses. Participants are asked whether they experienced each of 19 emotions "during or immediately after (within 1 week) the trauma" (yes/no). Participants were asked to identify all emotions that applied. The MERT was administered by a trained doctoral-level assessor at T1. For the current study, only the seven emotions that have garnered the most empirical support in terms of their associations with the outcome variables were examined (i.e., fear, horror, helplessness, disgust, sadness, anger, and numbness).

PTSD at T1

The Structured Clinical Interview for DSM-IV Axis 1 Disorders (SCID-IV; First, Spitzer, Williams, & Gibbon, 1997) is a clinician-administered semi-structured interview used to assess DSM-IV diagnoses. The PTSD module of the SCID-IV was administered by trained doctoral-level assessors over the telephone at T1 to assess for current PTSD. Assessment personnel met regularly to discuss cases to prevent interviewer drift and ensure diagnostic reliability. Inter-rater reliability for the SCID-IV was excellent ($\kappa = .91$).

MDD at T1

The Patient Health Questionnaire (PHQ; Spitzer, Kroenke, & Williams, 1999) is a self-administered version of the Primary Care Evaluation of Mental Disorders (PRIME-MD). The PHQ assesses the presence and frequency of a variety of psychological symptoms, which can be coded either continuously or categorically. For the purposes of this study, the 9-item depression subscale (PHQ-9) was used to assess the presence of MDD at T1; diagnostic categorization was made using published PHQ cutoffs (a score of five or more on the PHQ-9 and endorsement of either "little interest or pleasure in doing things" or "feeling down, depressed or hopeless" more than half the days in the last month; Spitzer, Williams, & Kroenke, n.d.). The PHQ-9 has demonstrated good criterion validity and internal consistency (Löwe, Unützer, Callahan, Perkins, & Kroenke, 2004). Cronbach's alpha for the full sample was excellent ($\alpha = .83$).

PTSD and MDD at T2

The Structured Clinical Interview for DSM-5 (SCID-5; First, Williams, Karg, & Spitzer, 2014) is a clinician-administered semi-structured interview used to assess diagnoses from the fifth edition of the DSM (DSM-5; American Psychiatric Association, 2013). The PTSD and MDD modules of the SCID-5 were administered by trained doctoral-level diagnosticians over the telephone at T2 to assess for current PTSD and MDD, respectively. Inter-rater reliability for the SCID-5 PTSD and MDD diagnoses was .82 and .75, respectively.

Data analyses

First, we conducted descriptive analyses to describe the demographic makeup of each of the two groups (i.e., the PTSD group and the MDD group); examine rates of endorsement for each peritraumatic response and covariate by group; and determine PTSD and MDD prevalence within each group. Second, we conducted correlational analyses among the peritraumatic emotions for both groups to determine the interrelatedness of the emotions. Third, for each group, a logistic regression was conducted with the seven peritraumatic emotional responses as predictor variables to examine the concurrent association between each emotion and PTSD and MDD at T1, respectively. To ensure that any observed association between peritraumatic emotional responses and PTSD and MDD was not better explained by demographic variables (e.g., Breslau et al., 1997) or other potential proxy variables known to be associated with the diagnoses, we controlled for age, race, gender, educational level, and the time elapsed between the date of the trauma and the administration of the MERT at T1. Finally, for each group, a second logistic regression was run to examine the association between the seven peritraumatic emotional responses and PTSD and/or MDD at T2, respectively. For this second set of regressions, additional covariates were added to the model including time elapsed between T1 and T2 assessments; T1 PTSD for the PTSD group; and T1 MDD for the MDD group. All data were analyzed using SPSS version 22.

Results

Frequency analyses indicated that for the participants in the PTSD group, the most commonly reported peritraumatic emotion was anger, reported by 85.5% of respondents, followed by fear (79.2%), sadness (70.6%), disgust (68.3%), helplessness (67.4%), numbness (65.2%), and horror (59.6%). In this group, PTSD prevalence at T1 was 56.7% according to the SCID-IV and 55.5% at T2 according to the SCID-5. For the participants in the MDD group, the most commonly reported emotion was anger, reported by 78.1% of respondents, followed by fear (73.7%),

sadness (67.7%), helplessness (64.1%), disgust (62.3%), numbness (57.8%), and horror (47.6%). For these participants, MDD prevalence at T1 was 21.3% according to the PHQ-9 and 15.3% at T2, according to the SCID-5 (see Table 1 for additional descriptive information).

Correlational analyses revealed that the peritraumatic emotions were not highly interrelated (see Table 2). Specifically, for the PTSD group, rs ranged from -.03 to .25. Both horror and disgust demonstrated significant (albeit moderate) associations with all of the other emotions, whereas the other five emotions demonstrated fewer significant associations. For the MDD group, rs ranged from -.04 to .31. Disgust was again significantly associated with all of the other emotions. However, the other emotions

Table 1. Descriptive characteristics for covariates and outcome variables used in logistic regressions.

Variables	PTSD group (n = 586)	MDD group (n = 334)
Education (completed at least some college; %)	88.2	87.7
Age (M, SD)	36.61 (9.22)	36.90 (10.00)
White (%)	80.5	80.5
Gender (% female)	51.9	52.7
Time between T1 and T2 (years; M, SD)	2.28 (.52)	2.25 (.52)
Time between trauma and T1 (years; M, SD)	7.30 (4.24)	7.59 (5.09)
T1 current PTSD diagnostic status (%)[a,c]	56.7	–
T2 current PTSD diagnostic status (%)[b,d]	55.5	40.4
T1 current MDD diagnostic status (%)[a,e]	–	21.3
T2 current MDD diagnostic status (%)[b,d]	16.1	15.3

Note. T1 = Time 1; T2 = Time 2; PTSD = Posttraumatic Stress Disorder; MDD = Major Depressive Disorder; PTSD group = participants who did not have MDD at T1 (used for analyses predicting PTSD at T1 and T2); MDD group; participants who did not have PTSD at T1 (used for analyses predicting MDD at T1 and T2). [a]Reflects DSM-IV Criteria. [b]Reflects DSM-5 Criteria. [c]Assessed using the Structured Clinical Interview for DSM-IV Disorders. [d]Assessed using the Structured Clinical Interview for DSM-5 Disorders. [e]Assessed using the Patient Health Questionnaire.

Table 2. Correlations between peritraumatic emotion scores within diagnostic groups.

PTSD group (n = 586)	1.	2.	3.	4.	5.	6.	7.
1. Afraid	1.00						
2. Helpless	.18*	1.00					
3. Horrified	.17*	.21*	1.00				
4. Angry	.02	.06	.09*	1.00			
5. Sad	−.03	.15*	.16*	.18*	1.00		
6. Disgusted	.15*	.14*	.25*	.23*	.22*	1.00	
7. Numb	.01	.08	.11*	.11*	.14*	.17*	1.00
MDD group (n = 334)	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**
1. Afraid	1.00						
2. Helpless	.30*	1.00					
3. Horrified	.26*	.29*	1.00				
4. Angry	.05	.10	.13*	1.00			
5. Sad	.04	.24*	.19*	.16*	1.00		
6. Disgusted	.15*	.25*	.26*	.31*	.28*	1.00	
7. Numb	−.04	.04	.10	.10	.07	.16*	1.00

Note. * p < .05; PTSD = Posttraumatic Stress Disorder; MDD = Major Depressive Disorder.

demonstrated fewer associations with one another than they had in the PTSD group; for example, numbness was only significantly associated with disgust, and this association was modest (.16; see Table 2).

We ran logistic regressions to examine the associations between the peritraumatic emotions and PTSD and MDD, respectively. For the PTSD group, the first logistic regression revealed that three of the seven peritraumatic emotions (i.e., numbness [$OR = 2.06$, $p < .01$], horror [$OR = 1.74$, $p < .01$], and anger [$OR = 2.24$, $p < .01$]) were significantly associated with T1 PTSD, even after controlling for covariates. However, in the second logistic regression, only peritraumatic numbness significantly predicted T2 PTSD ($OR = 1.78$, $p < .01$; see Table 3). For the MDD group, the first logistic regression indicated that only peritraumatic numbness ($OR = 2.17$, $p < .05$) was significantly associated with a concurrent diagnosis of MDD at T1 after controlling for covariates. Similarly, in the second logistic regression, peritraumatic numbness was again the only emotion that significantly predicted T2 MDD ($OR = 2.32$, $p < .05$; see Table 4).

Discussion

Our study addressed gaps in the literature by examining both the concurrent and longitudinal associations between seven peritraumatic emotional responses (fear, helplessness, horror, disgust, sadness, anger, and numbing) and both PTSD and MDD in a sample of OIF/OEF/OND veterans. Consistent with existing literature, results indicated that retrospective endorsement of peritraumatic numbness, anger, and horror was associated with a concurrent PTSD diagnosis, even after controlling for covariates. However, in contrast with past literature, our analyses

Table 3. Standardized logistic regressions of time 2 PTSD on time 1 peritraumatic emotions.

Variables	Estimate (B)	SE	OR
		Time 2 PTSD[b]	
Education	−.10	.07	.91
Age	.00	.01	1.00
White	−.33	.24	.72
Gender	−.06	.20	.95
Time between T1 and T2	−.01	.02	.99
Time between trauma and T1	.02	.02	1.02
T1 PTSD diagnostic status[a]	1.64	.19	5.14**
Peritraumatic fear	−.12	.24	.88
Peritraumatic helplessness	.02	.22	1.02
Peritraumatic horror	.17	.20	1.18
Peritraumatic anger	.00	.28	1.00
Peritraumatic sadness	−.22	.22	.80
Peritraumatic disgust	.29	.22	1.33
Peritraumatic numbness	.58	.20	1.78**

Note. T1 = Time 1; T2 = Time 2; PTSD = Posttraumatic Stress Disorder; OR = odds ratio.
[a]Assessed using SCID-IV. [b]Assessed using the SCID-5.
* $p < .05$. ** $p < .01$.

Table 4. Standardized logistic regressions of time 2 MDD on time 1 peritraumatic emotions.

Variables	Estimate (B)	SE	OR
		Time 2 MDD[b]	
Education	−.03	.13	.97
Age	−.01	.02	.99
White	−.88	.39	.41*
Gender	−.26	.37	.77
Time between T1 and T2	−.02	.03	.98
Time between trauma and T1	−.02	.04	.98
T1 MDD diagnostic status[a]	1.57	.36	4.81**
Peritraumatic fear	−.41	.41	.66
Peritraumatic helplessness	−.39	.41	.68
Peritraumatic horror	.46	.38	1.58
Peritraumatic anger	−.44	.40	.64
Peritraumatic sadness	−.23	.38	.79
Peritraumatic disgust	−.27	.40	.77
Peritraumatic numbness	.84	.37	2.32*

Note. T1 = Time 1; T2 = Time 2; MDD = Major Depressive Disorder; OR = odds ratio.
[a]Assessed using the Patient Health Questionnaire. [b]Assessed using the SCID-5.
* $p < .05$. ** $p < .01$.

did not demonstrate a concurrent association between PTSD and peritraumatic fear, helplessness, disgust, or sadness. Further, only peritraumatic numbing was concurrently associated with MDD; none of the other peritraumatic emotions examined demonstrated a significant association with this diagnosis. It is possible that these discrepant findings are a product of our sample; whereas we examined an exclusively veteran sample, other studies have measured these associations among non-veterans. Consistent with this possibility, the literature suggests that veterans and other individuals who are trained to handle occupationally related potentially traumatic events may have a qualitatively different peritraumatic experience than that of non-veterans (e.g., Adler, Wright, Bliese, Eckford, & Hoge, 2008; Creamer et al., 2005).

Our study also examined the longitudinal association between the peritraumatic emotions and PTSD and MDD, while controlling for baseline PTSD and MDD as well as other relevant covariates. In contrast to our cross-sectional findings, these results indicated that only endorsement of peritraumatic numbness at T1 predicted either PTSD or MDD at T2; none of the other peritraumatic emotions predicted either diagnosis longitudinally. This finding, in combination with the minimal correlations between the peritraumatic emotions, suggests that each of these peritraumatic experiences is a distinct entity and that peritraumatic numbness, and not just general peritraumatic distress, may have a unique relationship with both PTSD and MDD. It is possible that peritraumatic numbness is predictive of the development and/or maintenance of psychopathology because it is indicative of emotional suppression or dissociation, two mechanisms which have shown robust associations with both PTSD and MDD (Birmes et al., 2003; Breh & Seidler, 2007; Olde et al., 2005; Ozer et al., 2008; Roemer, Litz, Orsillo, &

Wagner, 2001). In this context, peritraumatic numbness could represent an emotional escape in the short term, which may prevent adequate processing of the traumatic event in the long term (Ehlers & Clark, 2000; Wagner & Linehan, 1998). However, additional research is needed to clarify the mechanism through which peritraumatic numbness may confer risk for and/or maintain PTSD and MDD.

Our findings must be considered in the context of study limitations. For example, as discussed above, it is possible that the associations between peritraumatic numbness and both PTSD and MDD are a byproduct of our sample. Specifically, all the participants in our sample had been deployed to Iraq and/or Afghanistan, and combat-exposed service members and veterans are less likely than other trauma survivors to report strong peritraumatic emotional responses (Adler et al., 2008; Breslau & Kessler, 2001; Creamer et al., 2005). It is also important to note that study participants were veterans who utilized VA healthcare services and were oversampled for PTSD status and female gender. Therefore, our sample may reflect a more severely symptomatic subsample of OEF/OIF/OND veterans, which may limit generalizability. Future research with other types of trauma survivors would help to clarify the generalizability of these associations. Lastly, because our study oversampled for PTSD, there was a very small sample of respondents with MDD at T2 who did not also meet criteria for PTSD at that point ($n = 15$). As a result, although we controlled for opposite diagnosis at T1, we could not do so for T2 and remain powered to detect an effect. Future research should replicate this study with a less comorbid sample to see whether the results hold. This is especially important because MDD may present differently in individuals with PTSD than in individuals without (Oquendo et al., 2005), which may suggest that the precipitants of MDD with and without comorbid PTSD differ as well.

As with all research examining peritraumatic emotional responses, our study is limited by its reliance on retrospective data, which may be prone to distortion (Engelhard, van den Hout, & McNally, 2008). Relatedly, the delayed, retrospective nature of the assessment of peritraumatic emotional responses in this sample limits our ability to make definitive conclusions about the prospective associations among peritraumatic numbness and PTSD or MDD.

Finally, there are limitations related to the measures used in the study. Two different measures were used to assess MDD (the PHQ and the SCID) at the two study time points, which may have impacted findings. In addition, whereas diagnostic status at T1 was representative of DSM-IV criteria for PTSD and MDD, diagnostic status at T2 was representative of DSM-5 criteria. Although changes to the PTSD diagnostic criteria have the potential to impact prevalence estimates, recent studies suggest otherwise (Hoge, Riviere, Wilk, Herrell, & Weathers, 2014). This is consistent with our results, which indicated that PTSD prevalence was

nearly identical at the two time points (see Table 1). The change from DSM-IV to DSM-5 is not a concern for MDD, because the diagnostic criteria were not altered. However, the change in modality of assessing MDD from self-report to interview may explain why prevalence rates of MDD decreased from T1 to T2. Further, it is worth noting that the SCID was used to assess for PTSD rather than the Clinician-Administered PTSD Scale (CAPS; Blake et al., 1995). However, although the CAPS is considered to be the gold standard for assessing PTSD (Weathers, Keane, & Davidson, 2001), the SCID, like the CAPS, is a widely used, reliable, structured interview (Lobbestael, Leurgans, & Arntz, 2011).

Despite these limitations, the results of our study may have important clinical implications. For example, if the retrospective reports of the peritraumatic emotional responses reported here are indicative of the actual emotions experienced at the time of the trauma, our findings suggest that the assessment of peritraumatic numbness in the period immediately following a traumatic event may help to identify individuals that are at greater risk for either developing or maintaining diagnoses of both PTSD and MDD. In addition, our correlational analyses suggest that it may be important to assess peritraumatic responses individually as opposed to assessing general peritraumatic distress. Premorbid identification and early implementation of trauma-specific treatments may improve our ability to prevent the full-blown development of PTSD and MDD, or the progression toward a more chronic form of the disorders. Further, consistent with research suggesting that peritraumatic responding may be associated with similar patterns of posttraumatic responding (e.g., Bennett, Modrowski, Kerig, & Chaplo, 2015), peritraumatic numbness may be indicative of subsequent posttraumatic emotional numbing. Emotional numbing may impair an individual's ability to engage emotionally with the traumatic memory and thus interfere with natural and therapy-related processes that promote recovery (Foa, Riggs, Massie, & Yarczower, 1995). Thus, peritraumatic numbness may indicate that emotional numbing in and of itself may be a relevant target for future treatment. Additional research is needed to empirically examine this possibility.

In summary, our findings suggest that, whereas a number of peritraumatic emotional responses are concurrently associated with PTSD, only peritraumatic numbness is associated with MDD concurrently and with either diagnosis longitudinally. These findings provide preliminary proof of concept that peritraumatic numbness may serve as an early marker for the development and/or maintenance of PTSD and MDD following a traumatic event and encourage additional research to further explore these associations.

Funding

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Examining the diagnostic utility of the *DSM-5* PTSD symptoms among male and female returning veterans

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Background: Posttraumatic stress disorder (PTSD) diagnostic criteria have been criticized for including symptoms that overlap with commonly comorbid disorders, which critics argue undermines the validity of the diagnosis and inflates psychiatric comorbidity rates. In response, the upcoming 11th edition of the International Classification of Diseases (ICD-11) will offer PTSD diagnostic criteria that are intended to promote diagnostic accuracy. However, diagnostic utility analyses have not yet assessed whether these criteria minimize diagnostic errors. The present study examined the diagnostic utility of each PTSD symptom in the fifth edition of the *Diagnostic and Statistical Manual for Mental Disorders* (*DSM-5*) for males and females.

Methods: Participants were 1,347 individuals enrolled in a longitudinal national registry of returning veterans receiving care at a Department of Veterans Affairs (VA) facility. Doctoral level clinicians assessed all participants using the PTSD module of the Structured Clinical Interview for *DSM*.

Results: Of the 20 symptoms examined, the majority performed in the fair to poor range on test quality indices. Although a few items did perform in the good (or better) range, only half were ICD-11 symptoms. None of the 20 symptoms demonstrated good quality of efficiency. Results demonstrated few sex differences across indices. There were no differences in the proportion of comorbid psychiatric disorders or functional impairment between *DSM-5* and ICD-11 criteria.

Conclusions: ICD-11 PTSD criteria demonstrate neither greater diagnostic specificity nor reduced rates of comorbidity relative to *DSM-5* criteria and, as such, do not perform as intended. Modifications to existing symptoms or new symptoms may improve differential diagnosis.

KEYWORDS
Diagnostic and Statistical Manual for Mental Disorders, diagnostic techniques and procedures, International Classification of Diseases, posttraumatic, psychological trauma, stress disorder

1 | INTRODUCTION

Since their introduction, the diagnostic criteria for posttraumatic stress disorder (PTSD) in the fifth edition of the *Diagnostic and Statistical Manual for Mental Disorders* (*DSM-5*; American Psychiatric Association [APA], 2013) have been criticized. One concern is that the new symptoms, including negative beliefs about oneself or the world (symptom D2), strong negative emotions (D4), irritable or aggressive behavior (E1), and reckless or self-destructive behavior (E2), may overlap with symptoms of commonly comorbid disorders (Brewin, Lanius,

Novac, Schnyder, & Galea, 2009; Hoge et al., 2016; Rosen & Lilienfeld, 2008; Rosen, Spitzer, & McHugh, 2008). Critics contend that including syndromally indistinct symptoms like these may undermine the validity of the diagnosis and inflate comorbidity rates (Rosen, Lilienfeld, Frueh, McHugh, & Spitzer, 2010; Spitzer, Rosen, & Lilienfeld, 2008).

To address this concern, some have suggested eliminating overlapping symptoms from the diagnosis (Spitzer, First, & Wakefield, 2007). Consistent with this perspective, the proposed PTSD criteria for the 11th edition of the International Classification of Diseases (ICD-11) includes only six symptoms (see Fig. 1), chosen based on

PTSD Symptom Clusters for DSM-III-R, DSM-IV, DSM-IV-TR, and DSM-5

DSM-5	DSM-IV-TR	DSM-III-R

Criterion A: Stressor
A1. Exposure to actual or threatened death, serious injury, or sexual violence in one (or more) of the following ways:
  1. Directly experiencing the traumatic event(s).
  2. Witnessing, in person, the event(s) as it occurred to others.
  3. Learning that the traumatic event(s) occurred to a close family member or close friend. *Event(s) must have been violent or accidental.*
  4. Experiencing repeated or extreme exposure to aversive details of the traumatic event(s). *Media does not count.*
A2. Eliminated
	Criterion A: Stressor
	A1. The person experienced, witnessed, or was confronted with an event that involved actual or threatened death or serious injury or a threat to the physical integrity of self or others.
	
	A2. The response involved intense fear, helplessness, or horror.
		Criterion A: Stressor
		A1. The person has experienced an event outside the range of usual human experience and that would be markedly distressing to almost anyone.

Cluster B (Intrusion) B1. Intrusive memories B2. Nightmares[a] B3. Flashbacks[a] B4. Psychological distress at exposure to cues B5. Physiological reactivity at exposure to cues	**Cluster B (Intrusive Recollection)** B1. Intrusive recollections B2. Nightmares B3. Flashbacks B4. Psychological distress at exposure to cues B5. Physiological reactivity at exposure to cues	**Cluster B (Intrusion)** B1. Intrusive recollections B2. Nightmares B3. Flashbacks B4. Psychological distress at exposure to cues
Cluster C (Avoidance) C1. Avoidance of thoughts and feelings[a] C2. Avoidance of external reminders[a]	**Cluster C (Avoidance and Numbing)** C1. Avoid thoughts and feelings C2. Avoid reminders	**Cluster C (Avoidance and Numbing)** C1. Avoid thoughts and feelings C2. Avoid reminders
Cluster D (Negative changes in cognitions and mood) D1. Inability to recall important aspect of trauma D2. Negative beliefs about oneself or the world[b] D3. Distorted self-blame or other-blame D4. Persistent negative emotions[b] D5. Diminished interest in significant activities[b] D6. Feelings of detachment or estrangement D7. Inability to experience positive emotions	C3. Psychogenic amnesia C7. Foreshortened future C4. Anhedonia C5. Detached from others C6. Psychic numbing	C3. Psychogenic amnesia C7. Foreshortened future C4. Anhedonia C5. Detached from others C6. Psychic numbing
Cluster E (Changes in arousal and reactivity) E1. Irritable or aggressive behavior[b] E2. Reckless or self-destructive or behavior[b] E3. Hypervigilance[a] E4. Exaggerated startle response[a] E5. Problems with concentration E6. Sleep disturbance	**Cluster D (Hyper-arousal)** D2. Irritability/anger D4. Hypervigilance D5. Exaggerated startle D3. Concentration difficulty D1. Disturbed sleep	**Cluster D (Hyper-arousal)** D2. irritability or outbursts of anger D4. hypervigilance D5. exaggerated startle response D3. difficulty concentrating D1. difficulty falling or staying asleep D6. physiologic reactivity
Dissociative Subtype Derealization Depersonalization		

Note: DSM-III-R and DSM-IV-R are aligned horizontally with DSM-5 counterparts.
[a]Symptom is present in both DSM-5 and ICD-11.
[b]Symptom commonly overlaps with comorbid disorders.

FIGURE 1 PTSD Symptom Clusters for DSM-III-R, DSM-IV, DSM-IV-TR, and DSM-5

the assumption that they are unique to PTSD (Cloitre, Garvert, Brewin, Bryant, & Maercker, 2013; Maercker et al., 2013). The ICD-11 committee reasoned that a diagnosis including only "core symptoms" would improve upon *DSM-5* criteria by enhancing diagnostic accuracy, reducing overlap with comorbid psychiatric conditions, and decreasing assessment time and burden (Brewin, 2013; Brewin et al., 2009; Maercker et al., 2013).

Although these justifications are compelling, determining if symptoms chosen to represent PTSD in ICD-11 are the most specific requires an examination of the diagnostic utility of these and other *DSM-5* PTSD symptoms. Diagnostic utility analyses provide information about the sensitivity (probability of endorsement among patients with the diagnosis), specificity (probability of lack of endorsement among patients without the diagnosis), and efficiency (probability that endorsement corresponds to diagnostic status) of each symptom (Kraemer, 1992). The ICD-11 approach of including only unique symptoms emphasizes diagnostic specificity.

In the only study to examine the diagnostic utility of each PTSD symptom, Holowka, Marx, Kaloupek, and Keane (2012) tested *DSM-III-R* (APA, 1987) PTSD diagnostic criteria in a large sample of male Vietnam veterans, finding that both unique and overlapping symptoms had high levels of sensitivity (e.g., hypervigilance and startle) and specificity (e.g., nightmares and difficulty concentrating). Although the authors

noted that intrusive memories and detachment from others most accurately predicted the overall PTSD diagnosis, diagnostic efficiency was not reported.

In this study, we examined the diagnostic utility of each *DSM-5* PTSD symptom, expanding on Holowka et al. (2012) work in several ways. First, we included both male and female participants because research suggests that men and women may have different PTSD symptom profiles (Fullerton et al., 2001; Green, 2003; Zlotnick, Zimmerman, & Wolfsdorf, 2001), suggesting that the diagnostic utility of each PTSD symptom may vary by gender. Second, as measures of test performance (i.e., sensitivity, specificity, efficiency) could be inflated due to the high prevalence of PTSD in our sample, we examined measures of test quality (quality of sensitivity, QSN; quality of specificity, QSP; quality of efficiency, QEF), which are superior to measures of test performance because they calibrate for chance agreement between test and diagnosis (Kraemer, 1992). Third, we explored the efficiency of each PTSD item. Finally, we examined whether ICD-11 criteria reduced psychiatric comorbidity.

Consistent with Holowka et al. (2012), of the six ICD-11 PTSD symptoms, we hypothesized that nightmares (B2) and hypervigilance (E3) would demonstrate the highest QSN, and that nightmares (B2) and flashbacks (B3) would demonstrate the highest QSP. Based on the ICD-11 committee's rationale, we hypothesized that ICD-11

symptoms would demonstrate strong QSP. Similarly, we expected a lower proportion of comorbid disorders among participants who met criteria for PTSD under ICD-11 criteria than those that met under *DSM-5*. Consistent with Holowka et al., we hypothesized that symptoms both unique to PTSD and overlapping with other disorders would demonstrate diagnostic utility. However, because PTSD diagnostic criteria have changed from *DSM-III-R* to *DSM-5*, and because our analytic strategy differed from Holowka et al., we did not have any a priori hypotheses regarding the diagnostic utility of these additional symptoms. Finally, because no study has examined the diagnostic utility of each PTSD symptom by gender, our examination of gender differences was exploratory.

2 | MATERIALS AND METHODS

2.1 | Participants

Participants were veterans enrolled in the Veterans After-Discharge Longitudinal Registry (Project VALOR), a longitudinal national registry of Operation Enduring Freedom and Operation Iraqi Freedom (OEF/OIF) Army and Marine Corps veterans (Rosen et al., 2012). To be included in Project VALOR, veterans must have undergone a mental health evaluation at a VA facility. Veterans with probable PTSD according to VA medical records (at least two instances of a PTSD diagnosis by a mental health professional associated with two separate visits) were oversampled to create a 3:1 (PTSD:no PTSD) ratio. Veterans without any PTSD diagnoses during the same time frame were eligible to be included in the no PTSD group. Veterans with just one PTSD diagnosis during the same window were excluded. As the registry was assembled between July 2008 and December 2009, diagnoses were made using *DSM-IV* (APA, 1994) criteria. Females were oversampled to create a 1:1 sex ratio. Potential Project VALOR participants were recruited from a roster of veterans, provided by the VA Environmental Epidemiology Service, who met inclusion criteria. Potential participants ($n = 4,331$) were contacted by phone. Of these, 2,712 (62.6%) consented to participate. Of those, 2,169 (80.0%) completed study questionnaires and 1,649 (60.8%) completed both the questionnaires and the diagnostic interview. At that time (Time 1 [T1], December 2009 to September 2012), *DSM-IV* criteria were available and the Structured Clinical Interview for *DSM-IV* (SCID-IV; First, Spitzer, Gibbon, & Williams, 1996) was used during this interview. Data from these 1,649 veterans were included in Project VALOR as T1 data. At T1, 75.9% of participants met criteria for PTSD on the SCID-IV. The present study consisted of 1,347 veterans who participated in Time 2 (T2; September 2013 to August 2014) of Project VALOR. At that time, *DSM-5* criteria were available and the SCID-5 (First, Williams, Karg, & Spitzer, 2015) was used to assess these participants.

2.2 | Measures

2.2.1 | Demographics

Participants completed a demographics questionnaire online or by mail. They reported their age, sex, and race.

2.2.2 | PTSD diagnosis

The SCID-5 PTSD module was used to assess current (past month) PTSD symptoms and diagnostic status. Though the SCID-5 for PTSD has not been evaluated for psychometric properties, *DSM-5* PTSD criteria demonstrated good reliability ($\kappa = .69$) in field trials (Regier et al., 2013). Of note, PTSD prevalence was higher in the *DSM-5* field trials than in most populations, potentially resulting in an inflated kappa. In the present study, interrater agreement was excellent ($\kappa = .82$) among a random subset of 100 interviews that were rated by an assessor who did not complete the initial interview.

2.2.3 | Depression diagnosis

The SCID-5 MDD module was used to assess for current (past month) MDD diagnostic status. The SCID-5 for MDD has not been evaluated for psychometric properties, and *DSM-5* criteria has demonstrated questionable reliability ($\kappa = .20–.35$; Regier et al., 2013). In the present study, assessment of interrater agreement for the MDD module was identical to that for the PTSD module, and was excellent ($\kappa = .75$).

2.2.4 | Alcohol use disorder

The Alcohol Use Disorders Identification Test (AUDIT) is a 10-item questionnaire that was used to classify participants with problematic alcohol use (Saunders, Aasland, Babor, De la Fuente, & Grant, 1993). In this study, Cronbach's α was .87. A cut-score of 8 was used to indicate hazardous and harmful alcohol use (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Conigrave, Hall, & Saunders, 1995).

2.2.5 | Panic syndrome and generalized anxiety disorder

The PHQ is a self-report version of the Primary Care Evaluation of Mental Disorders (PRIME-MD; Spitzer, Kroenke, & Williams, 1999). It is a 58-item measure that can be used to determine probable diagnostic status for several mental disorders. We used scoring procedures outlined in the measure's manual to create dichotomous diagnostic categories for panic syndrome and generalized anxiety disorder (GAD). Cronbach's α was .72 and .85 for panic syndrome and GAD, respectively.

2.2.6 | Functional impairment

The inventory of psychosocial functioning (IPF) is an 80-item self-report measure assessing PTSD-related functional impairment (Rodriguez, Holowka, & Marx, 2012). It yields an overall score of psychosocial impairment, with higher scores indicating greater impairment. In this study, Cronbach's α was .73. We used a cutoff of 51 to indicate psychosocial impairment, which is indicative of "severe impairment" (Bovin et al., in press).

2.3 | Procedure

Participants completed questionnaires online or by mail and were then interviewed via telephone by doctoral level clinicians. All participants completed T1 of Project VALOR ~2.5 years prior to the current assessment. Participants provided informed consent prior to participation. The study was approved by the local Institutional Review Boards and the Human Research Protection Office of the US Army

Medical Research and Materiel Command. Participants were compensated $100 for completing T2 of Project VALOR.

2.4 | Analyses

Using SPSS version 24, we computed percentages of participants who met criteria for each PTSD symptom based on the SCID-5, as well as the number and percent of participants who met criteria for PTSD based on both *DSM-5* and ICD-11 criteria (IBM Corp, 2016). We compared the prevalence of these diagnoses via comparative error (CE) analyses. CE was calculated using the following equation:

$$CE = 1.96x\sqrt{(r1(100 - r1) \div s1) + (r2(100 - r2) \div s2)}.$$

In this equation, $r1$ is the percentage response for the first group, $r2$ is percentage response for the second group, $s1$ is the sample size of the first group, and $s2$ is the sample size of the second group. Significance was calculated using an online calculator (EasyCalculation.com).

For diagnostic utility analyses, we created 2×2 contingency tables to classify participants based on the presence/absence of each PTSD symptom and presence/absence of PTSD diagnosis. We analyzed one 2×2 table for each of the 20 PTSD symptoms. Each table classified participants into one of four cells: true positives (symptom+ and diagnosis+), true negatives (symptom− and diagnosis−), false positives (symptom+ and diagnosis−), and false negatives (symptom− and diagnosis+). To avoid conditional dependence issues, the 2×2 table for each symptom was created based on a PTSD diagnosis that was calculated without that symptom (e.g., the B1 2×2 table was created using a PTSD diagnosis that was calculated with B1 excluded). For each 2×2 table, three measures of test performance (sensitivity, specificity, and efficiency) and three measures of test quality were calculated using DAG_STAT software (Mackinnon, 2000). Test quality measures were weighted κ coefficients as proposed by Kraemer (1992) for QSN ($\kappa[1]$), QSP ($\kappa[0]$), and QEF ($\kappa[.5]$). We judged the clinical significance of κ coefficients using Cicchetti (1994)'s guidelines: $\kappa \leq .40$ is poor, $\kappa \geq .41$ and $< .60$ is fair, $\kappa \geq .60$ and $< .75$ is good, and $\kappa \geq .75$ is excellent. We conducted all analyses separately for males and females.

To determine whether ICD-11 criteria reduce comorbidity, we calculated the CE between the proportion of those with a *DSM-5* PTSD diagnosis and a comorbid disorder (e.g., alcohol use disorder [AUD]) and those with an ICD-11 PTSD diagnosis and the same comorbidity.

3 | RESULTS

Participant demographics are reported in Table 1. PTSD diagnostic prevalence was not significantly different between ICD-11 and *DSM-5* criteria, with 846 (62.8%) participants meeting criteria for *DSM-5* PTSD and 874 (64.9%) for ICD-11 PTSD (CE = 3.63, ns). Fifty-one (3.8%) participants met criteria for *DSM-5* but not ICD-11, and 79 (5.9%) met criteria for ICD-11 but not *DSM-5*. One hundred thirty (9.6%) cases were discrepant between ICD-11 and *DSM-5*. There were no differences in the proportion of comorbid depression (CE = 4.48, *n.s.*), GAD (CE = 4.54, *n.s.*), panic syndrome (CE = 4.70, *n.s.*), AUD (CE

= 4.17, *n.s.*), or functional impairment (CE = 1.68, *n.s.*) between those meeting criteria under *DSM-5* versus ICD-11.

Regarding quality indices, items demonstrated similar patterns across gender. Only four items achieved good QSN. Three of these are considered "core" PTSD symptoms (intrusive memories [B1], avoidance of external reminders [C2], and hypervigilance [E3]); the fourth is not (feelings of detachment or estrangement [D6]). Of note, intrusive memories (B1) demonstrated good QSN for men, but only fair QSN for women.

Two symptoms had, at minimum, good QSP for both men and women; inability to experience positive emotions (D7) demonstrated good QSP for both genders, while flashbacks (B3) demonstrated excellent QSP for women and good QSP for men. Distorted self- or other-blame (D3) and persistent negative emotions (D4) had good QSP for women and fair QSP for men. Reckless or self-destructive behavior (E2) demonstrated good QSP among men and fair QSP among women. Only one ICD-11 symptom demonstrated good QSP (flashbacks [B3]).

None of the 20 symptoms assessed had good or excellent QEF. Eight symptoms demonstrated fair QEF for both genders. Three additional symptoms had fair QEF for men but poor QEF for women: persistent negative emotions (D4), exaggerated startle response (E4), and sleep disturbance (E6). In contrast, avoidance of thoughts and feelings (C1) demonstrated fair QEF for women but poor QEF for men (see Table 2).

Two symptoms did not perform well across test quality indices. Both inability to recall important aspects of the trauma (D1) and irritable or aggressive behavior (E1) demonstrated poor diagnostic utility across all three indices.[1]

4 | DISCUSSION

Contrary to hypotheses, the only proposed ICD-11 symptom that demonstrated good (for males) or excellent (for females) QSP was flashbacks (B3). All other ICD-11 symptoms demonstrated fair or poor QSP. Also contrary to hypotheses, there were no differences in rates of comorbid psychiatric disorders or psychosocial functioning between those who met criteria for PTSD under *DSM-5* versus ICD-11. These findings suggest that the proposed ICD-11 PTSD criteria may not perform as anticipated.

Hypotheses stemming from work done by Holowka et al. (2012) were partially supported. Both symptoms unique to PTSD and those thought to overlap with comorbid disorders demonstrated good diagnostic utility. Although our analyses do provide guidance as to the most specific PTSD symptoms, creating a diagnosis using only these items is not recommended. A definition including only specific items, even those with excellent QSP, would inflate the number of false negatives. Ideally, a definition would include a mix of items with high QSP, QSN, and QEF. Inclusion of diagnostically efficient symptoms is particularly important because they minimize diagnostic errors. Therefore, diagnostically efficient, rather than specific, symptoms would be most likely to separate PTSD from other commonly comorbid disorders.

In this study, none of the *DSM-5* or ICD-11 PTSD symptoms demonstrated good or excellent QEF. This does not necessarily suggest that the *DSM-5* and ICD-11 diagnostic conceptualizations are inherently

TABLE 1 Demographic information

	Females (n = 689)	Males (n = 658)	All Participants (n = 1347)
Age—M (SD)	40.01 (9.36)	41.40 (10.14)	40.69 (9.77)
Race/ethnicity (%)			
White	487 (70.7)	528 (80.2)	75.4
Black	147 (21.3	71 (10.8)	16.8
American Indian or Alaska Native	18 (2.6)	20 (3.0)	2.8
Asian	18 (2.6)	6 (.9)	1.8
Pacific Islander	4 (.6)	6 (.9)	0.7
Other Race	15 (2.2)	27 (4.1)	3.1
Hispanic	89 (12.9)	79 (12.0)	12.4

flawed. That a number of symptoms demonstrated good to excellent QSN and QSP indicates that *DSM-5* and ICD-11 PTSD diagnostic criteria include symptoms that, when used in combination, may adequately detect the presence or absence of PTSD. Unfortunately, results of this study cannot provide guidance on which symptom combination is optimal. It is possible that delineating symptoms that achieve good to excellent QEF may be accomplished by modifying wording of existing criteria, especially for symptoms that exhibited the highest QEF.

It is also possible that, despite modification, no current PTSD symptoms can yield good or excellent QEF. Instead, there may be symptoms that are not part of any classification system that better distinguish PTSD from other disorders. PTSD assessment instruments such as the Mississippi Scale for Combat-Related PTSD (Keane, Caddell, & Taylor, 1988) and the Detailed Assessment of Posttraumatic Stress (Briere, 2001) include more items than just those that directly correspond to *DSM* diagnostic criteria. The items included on these and other scales might be worth investigating as diagnostic indicators.

Rather than an issue of incomplete content, our inability to identify items demonstrating good or excellent QEF could be due to measurement error. The SCID-5 has not been validated and does not encourage the same in-depth probing as other PTSD interviews (i.e., the Clinician Administered PTSD Scale for *DSM-5*; Weathers et al., 2013). Symptoms with only fair QEF in the current study might demonstrate good QEF with a different diagnostic tool. This possibility awaits empirical exploration.

Although many of our findings were consistent with Holowka et al. (2012) investigation of *DSM-III-R* PTSD symptoms, there were notable differences. However, Holowka et al. found that nightmares and physiological reactivity to cues were diagnostically specific, these symptoms demonstrated only fair QSP in our study. Such differences may reflect the fact that Holowka et al. examined test performance rather than test quality in a sample comprised entirely of male Vietnam War veterans, rather than of both sexes and who served in more recent conflicts. The broad similarities found across the two studies, however, suggest that despite significant revisions to the PTSD criteria between *DSM-III-R* and *DSM-5*, symptom performance is consistent.

Findings were generally consistent across genders. The five symptoms with the highest kappas across all three quality indices tended to be the same for men and women. Although males and females may

differ somewhat in PTSD symptom presentation, the same symptoms seem to signal the presence and absence of PTSD in both sexes.

Our findings have important clinical implications beyond diagnostic classification. The identification of symptoms with high QSN, which minimize false negatives, has implications for screening tools. One common PTSD screening tool, the primary care PTSD screen (PC-PTSD; Prins et al., 2004), was recently revised for *DSM-5* (Prins et al., 2016). Our results suggest that the PC-PTSD-5 includes items with the highest QSN (e.g., avoidance of external reminders [C2] and hypervigilance [E3]). However, it also includes distorted self- or other-blame (D3), which has good QSP but poor QSN. Application of our findings to the PC-PTSD-5 may be limited as the PC-PTSD-5 was designed for use in primary care settings. However, this example highlights the relevance of our study to screening tool evaluations.

Similarly, the identification of symptoms with high QSP (e.g., flashbacks [B3]), distorted self- or other-blame [D3], and persistent negative emotions [D4]), which decrease false positives, could be useful for clinicians with limited resources hoping to confirm a PTSD diagnosis (Kraemer, 1992). Future work is needed to examine whether truncated confirmatory assessment tools could be developed.

Both irritable or aggressive behaviors (E1) and inability to recall important aspects of the trauma (D1) demonstrated poor diagnostic utility across all indices. Findings for D1 are consistent with the broader literature (Armour et al., 2015; Holowka et al., 2012; Keane et al., 2014). Therefore, it may be appropriate to remove these symptoms from the diagnosis.

Study findings should be viewed in light of limitations. First, the high prevalence of PTSD in this sample likely resulted in a deflated estimation of false positives, which could underrepresent the number of discrepant cases between *DSM-5* and ICD-11 diagnoses. In more representative samples of OEF/OIF veterans, in which PTSD prevalence ranges from 15 to 20% (Ramchand et al., 2010), the corresponding increase in false positives would result in a higher proportion of discrepant cases. This is a limitation of other recent work comparing ICD-11 and *DSM-5* criteria as well (e.g., Hafstad, Thoresen, Wentzel-Larsen, Maercker, & Dyb, 2017). Future research should investigate these differences in samples with PTSD prevalence rates that are comparable to populations of interest. Second, in the present study, both *DSM-5* and ICD-11 were assessed using the SCID-5. Ideally, these criteria would

TABLE 2 Endorsement of PTSD symptoms and diagnostic utility analyses for DSM-5

Symptom	PTSD Status Absent %Men/%Women ($n_{men} = 244$) ($n_{women} = 257$)	Present %Men/%Women ($n_{men} = 414$) ($n_{women} = 432$)	Sens Men/Women	Spec Men/Women	Eff Men/Women	$\kappa(0)$[a] Men/Women	$\kappa(.5)$[b] Men/Women	$\kappa(1)$[c] Men/Women
Cluster B (intrusion)								
B1. Intrusive memories[d]	50.0/40.2	92.5/89.1	.92/.88	.47/.56	.76/.77	.32/.39	.43/.47	.65/.57
B2. Nightmares[e]	28.2/23.2	71.5/73.6	.72/.72	.73/.75	.72/.73	.53/.56	.42/.45	.35/.37
B3. Flashbacks[e]	5.9/4.4	25.6/28.7	.25/.28	.94/.96	.48/.50	.70/.79	.14/.17	.08/.10
B4. Psychological distress at exposure to cues[d]	31.4/29.4	76.8/76.9	.77/.77	.69/.73	.74/.76	.50/.56	.45/.48	.40/.42
B5. Physiological reactivity at exposure to cues[d]	28.3/30.1	77.8/80.3	.77/.79	.71/.70	.75/.76	.53/.52	.46/.48	.41/.45
Cluster C (avoidance)								
C1. Avoidance of thoughts and feelings[e]	40.5/41.0	84.3/88.4	.83/.88	.54/.56	.72/.76	.33/.38	.38/.46	.45/.56
C2. Avoidance of external reminders[e]	43.6/52.8	93.0/94.9	.92/.94	.45/.40	.71/.72	.27/.25	.39/.37	.67/.70
Cluster D (negative changes in cognitions and mood)								
D1. Inability to recall important aspect of the trauma[d]	13.6/15.7	23.2/33.8	.22/.31	.83/.80	.43/.48	.15/.27	.04/.09	.02/.05
D2. Negative beliefs about oneself or the world[d]	30.6/34.2	79.0/81.9	.78/.80	.66/.61	.74/.74	.45/.41	.43/.42	.42/.43
D3. Distorted self- or other-blame	10.5/18.5	52.7/61.3	.51/.60	.87/.80	.63/.67	.66/.56	.32/.35	.21/.25
D4. Persistent negative emotions[d]	14.1/17.5	64.0/66.2	.63/.64	.84/.79	.70/.69	.66/.58	.41/.39	.30/.29
D5. Diminished interest in significant activities[d]	20.9/23.5	78.7/76.4	.78/.79	.75/.72	.77/.74	.58/.53	.51/.46	.46/.40
D6. Feelings of detachment or estrangement	33.6/36.1	89.9/90.0	.89/.89	.62/.58	.79/.78	.46/.41	.53/.49	.62/.61
D7. Inability to experience positive emotions[d]	14.5/14.0	55.3/49.8	.55/.49	.85/.86	.65/.61	.63/.61	.33/.28	.23/.18
Cluster E (changes in arousal and reactivity)								
E1. Irritable or aggressive behavior[d]	37.4/38.9	68.8/70.8	.69/.70	.65/.61	.68/.67	.40/.34	.32/.29	.27/.25
E2. Reckless or self-destructive behavior[d]	9.5/5.2	29.2/22.7	.29/.22	.91/.94	.49/.46	.59/.67	.15/.12	.08/.06
E3. Hypervigilance[e]	72.7/63.8	95.4/95.4	.95/.95	.28/.34	.72/.73	.17/.22	.27/.33	.63/.65
E4. Exaggerated startle response[e]	40.0/52.0	83.8/86.3	.83/.85	.61/.46	.76/.72	.43/.27	.45/.33	.47/.42
E5. Problems with concentration[d]	40.5/39.3	84.5/84.3	.84/.83	.59/.58	.76/.74	.42/.40	.44/.42	.47/.44
E6. Sleep disturbance[d]	43.4/50.4	84.5/87.2	.85/.86	.58/.47	.76/.72	.40/.29	.44/.35	.48/.45

PTSD, posttraumatic stress disorder; Sens, sensitivity; Spec, specificity; Eff, efficiency.

[a] $\kappa(0) =$ quality of specificity.
[b] $\kappa(.5) =$ quality of efficiency.
[c] $\kappa(1) =$ quality of sensitivity.
[d] Symptom commonly overlaps with those in comorbid disorders.
[e] Symptom is present in both DSM-5 and ICD-11.

TABLE 3 Endorsement of PTSD symptoms and diagnostic utility analyses for ICD-11

Symptom	PTSD status Absent %Men/%Women (n_{men} = 291) (n_{women} = 299)	PTSD status Present %Men/%Women (n_{men} = 344) (n_{women} = 361)	Sensitivity Men/Women	Specificity Men/Women	Efficiency Men/Women	$\kappa(0)$[b] Men/Women	$\kappa(.5)$[c] Men/Women	$\kappa(1)$[d] Men/Women
Cluster B (intrusion)								
B1. Intrusive memories[e]	57.7/50.8	94.8/89.6	.95/.90	.42/.49	.71/.71	.26/.30	.39/.40	.76/.63
B2. Nightmares[a]	10.0/8.4	95.9/95.6	.88/.88	.50/.52	.57/.59	.12/.14	.21/.23	.72/.72
B3. Flashbacks[a]	1.7/1.0	33.4/36.3	.31/.33	.94/.94	.61/.62	.67/.72	.24/.27	.14/.17
B4. Psychological distress at exposure to cues[e]	40.5/38.5	78.5/78.4	.78/.79	.59/.61	.70/.71	.34/.36	.38/.41	.45/.46
B5. Physiological reactivity at exposure to cues[e]	37.6/39.1	80.2/82.5	.80/.83	.62/.61	.72/.73	.38/.38	.43/.44	.50/.53
Cluster C (avoidance)								
C1. Avoidance of thoughts and feelings[a]	46.4/51.5	88.4/88.9	.87/.88	.49/.46	.69/.68	.26/.25	.37/.35	.59/.59
C2. Avoidance of external reminders[a]	56.0/62.2	92.7/95.3	.92/.95	.39/.33	.64/.63	.19/.17	.30/.28	.66/.73
Cluster D (negative changes in cognitions and mood)								
D1. Inability to recall important aspect of the trauma	15.5/22.7	23.8/31.3	.24/.31	.84/.77	.52/.52	.23/.17	.08/.08	.05/.05
D2. Negative beliefs about oneself or the world[e]	46.4/51.2	75.6/77.0	.66/.77	.65/.49	.66/.64	.36/.22	.30/.27	.25/.34
D3. Distorted self- or other-blame	22.7/30.8	51.2/59.3	.51/.59	.77/.69	.63/.64	.41/.33	.28/.28	.21/.24
D4. Persistent negative emotions[e]	29.2/33.1	61.6/62.6	.62/.63	.71/.67	.66/.65	.38/.33	.32/.30	.28/.27
D5. Diminished interest in significant activities[e]	41.9/43.5	73.0/69.8	.73/.70	.58/.56	.66/.64	.28/.25	.31/.26	.34/.28
D6. Feelings of detachment or estrangement	56.7/56.0	82.0/83.9	.82/.84	.43/.44	.64/.66	.19/.21	.26/.29	.39/.44
D7. Inability to experience positive emotions[e]	28.5/26.4	52.0/46.3	.52/.46	.71/.74	.61/.59	.31/.29	.23/.19	.19/.14
Cluster E (changes in arousal and reactivity)								
E1. Irritable or aggressive behavior[e]	44.0/49.2	69.5/68.7	.69/.69	.56/.51	.63/.61	.24/.18	.26/.20	.28/.22
E2. Reckless or self-destructive behavior[e]	13.7/13.7	29.7/19.1	.30/.19	.86/.86	.56/.50	.39/.17	.15/.05	.09/.03
E3. Hypervigilance[a]	75.3/69.9	98.0/96.4	.98/.96	.21/.27	.57/.60	.10/.13	.18/.23	.81/.74
E4. Exaggerated startle response[a]	47.8/56.9	86.3/88.9	.86/.89	.51/.41	.70/.66	.29/.21	.38/.31	.56/.55
E5. Problems with concentration[e]	55.0/54.8	81.4/80.0	.82/.80	.45/.45	.65/.64	.21/.20	.27/.26	.40/.36
E6. Sleep disturbance[e]	53.4/58.5	84.6/87.3	.85/.88	.47/.41	.67/.67	.24/.21	.33/.30	.50/.51

PTSD, posttraumatic stress disorder; Sens, sensitivity; Spec, specificity; Eff, efficiency.

[a]Symptom is present in both DSM-5 and ICD-11.

[b]$\kappa(0)$ = quality of specificity.

[c]$\kappa(.5)$ = quality of efficiency.

[d]$\kappa(1)$ = quality of sensitivity.

[e]Symptom commonly overlaps with those in comorbid disorders.

have been assessed independently. However, there currently exists no standardized assessment for ICD-11 PTSD.

5 | CONCLUSION

Our results suggest that the *DSM-5* PTSD criteria include symptoms with strong QSN and QSP. This mix is important for limiting false positives and false negatives(Kraemer, 1992). However, none of the current symptoms demonstrated strong QEF. Contrary to hypotheses, our findings suggest that ICD-11 criteria may not perform as intended; items chosen for presumed QSP performed otherwise. Further, participants diagnosed with PTSD under each set of diagnostic criteria exhibited similar rates of psychiatric comorbidities and similar levels of functional impairment. As ICD-11 offers a briefer set of symptoms, it may be more convenient to use ICD-11 criteria in situations where diagnoses must be made quickly. In contrast, assessments using *DSM-5* criteria may offer information regarding treatment targets (e.g., distorted self- or other-blame [D4] for use in cognitive processing therapy; Resick, Monson, & Chard, 2006). However, only 10% of cases were discrepant between *DSM-5* and ICD-11 in this study, this number will increase as prevalence decreases. Therefore, choice of diagnostic classification system has important implications for over- and under-diagnosis. We encourage future research to use these findings as a starting point for garnering a better understanding of the PTSD construct.

ENDNOTE

[1] We conducted the same analyses using the ICD-11 PTSD diagnosis as the comparison. Three diagnostic utility scores remained the same as when compared to the *DSM-5* PTSD diagnosis, 12 scores improved but not enough to affect their level of clinical significance, and two scores (QSN for men on psychological distress at exposure to cues [B2] and hypervigilance [E3]) increased in level of clinical significance, from poor to fair and poor to excellent, respectively. Of these, only hypervigilance is included in the ICD-11 diagnostic criteria. Diagnostic utility was consistently poorer when compared to the ICD-11 diagnosis (see Table 3).

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Mild Traumatic Brain Injury, PTSD, and Psychosocial Functioning Among Male and Female U.S. OEF/OIF Veterans

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This study examined the unique and combined relationship between mild traumatic brain injury (mTBI) and posttraumatic stress disorder (PTSD) with psychosocial functioning in a cohort of 1,312 U.S. male and female veterans of Operations Enduring Freedom (OEF) and Iraqi Freedom (OIF) enrolled in the Veterans After-Discharge Longitudinal Registry (Project VALOR). We assessed mTBI with structured screening questions reflective of current TBI classification standards and PTSD via the SCID-IV PTSD module; all other variables were assessed by self-report questionnaires. We identified significant diagnostic group differences in psychosocial functioning for both sexes. Individuals with PTSD, with or without a history of mTBI, reported significantly worse psychosocial functioning than individuals with mTBI alone or neither mTBI nor PTSD (males, $\eta^2_p = .11$, $p < .001$; females, $\eta^2_p = .14$, $p < .001$), even after adjusting for demographics and severity of chronic pain. The results suggested that veterans experiencing PTSD, regardless of whether they had a history of mTBI, were at increased risk for long-term psychosocial impairment. Further research examining possible benefits from improved access to resources and treatment to address these needs would be valuable.

Mild traumatic brain injury (mTBI) and posttraumatic stress disorder (PTSD) are considered to be the signature injuries of Operations Enduring Freedom (OEF) and Iraqi Freedom (OIF; U.S. Department of Defense Task Force on Mental Health, 2007; Hayward, 2008) and do not appear to be fully independent of each other. Specifically, OEF/OIF veterans reporting a history of mTBI also frequently reported elevated PTSD symptoms (Tanalian & Jaycox, 2008), potentially resulting in complex clinical presentations. In addition, there is evidence to suggest that PTSD and mTBI likely affect functional impairment among OEF/OIF veterans (Lippa et al., 2015).

Research with veterans has consistently found strong associations between PTSD symptoms and long-term functional impairment in social, occupational, and other domains (see review by Goldberg et al., 2014; Schnurr, Lunney, Bovin, & Marx, 2009; Shea, Vujanovic, Mansfield, Sevin, & Liu, 2010). In contrast, findings on the association between functional impairment and mTBI are inconsistent (e.g., Bryant et al., 2010; Pietrzak, Johnson, Goldstein, Malley, & Southwick, 2009; Polusny et al., 2011; Vanderploeg, Curtiss, Luis, & Salazar, 2007; Vasterling et al., 2012). This inconsistency may be due to varying study methods (e.g., different samples and different measures), as well as varying definitions of impairment and mTBI across studies.

Additionally, most of the research on the associations among veterans between PTSD, mTBI, and psychosocial functioning has focused almost exclusively on male participants. Available studies comparing the psychosocial functioning of male and female veterans with a history of mTBI have been inconclusive. Research has suggested that although females report greater postconcussive symptoms following mTBI (Bazarian, Blyth, Mookerjee, He, & McDermott, 2010), they did not report significantly greater functional impairment (Bazarian et al., 2010; Fang et al., 2015). These studies, however, did not examine the contribution of both PTSD and mTBI to

psychosocial functioning. The associations between mTBI, PTSD, and psychosocial functioning have yet to be fully examined using standardized diagnostic interviews and an adequate measure of psychosocial impairment in a sample of OEF/OIF veterans. Additionally, psychosocial functioning and features of mTBI such as loss of consciousness (LOC), single versus multiple events, and presence of postconcussive symptoms (PCS) have not been explored with a large OEF/OIF cohort containing sufficient numbers of females to conduct sex-specific comparisons (e.g., Pietrzak et al., 2009).

This study examined the separate and combined relationship between mTBI history and PTSD with psychosocial functioning in a sample of OEF/OIF veterans with adequate representation of females to examine sex-specific associations. Given the aforementioned evidence supporting an association between PTSD and functional impairment, we hypothesized that after adjusting for demographics, pain severity, and probable major depression, those without a history of PTSD or mTBI as well as those with only a history of mTBI would report significantly better psychosocial functioning than those with a history of PTSD alone or a history of mTBI and PTSD. We also conducted exploratory analyses examining the associations of psychosocial functioning with mTBI-related LOC, history of single versus multiple mTBIs, and presence of PCS, because research has found that these variables may be related to various aspects of functioning (Belanger, Spiegel, & Vanderploeg, 2010; Schiehser et al., 2014).

Method

Participants and Procedure

For this investigation, we used data from a subgroup of the 1,649 (47.2% male) nationally dispersed United States Army and Marine Corps veterans enrolled in the Veterans After-Discharge Longitudinal Registry (Project VALOR) between 2009 and 2012 (see Rosen et al., 2012 for full study description). Eligibility for Project VALOR required either separation from active duty after serving in OEF/OIF or completion of at least one Reserve/National Guard deployment in support of OEF/OIF. Individuals enrolled in Project VALOR were also required to have undergone a mental health evaluation at a Veterans Affairs (VA) facility, indicated by a diagnostic interview or psychotherapy procedure code between July 2008 and December 2009. They also must not have been participating in a clinical trial at the time of enrollment. Individuals with probable PTSD were oversampled at a 3:1 ratio; female veterans were also oversampled at a 1:1 ratio to examine sex differences (for additional recruitment details, see Wisco et al., 2014). The Project VALOR study was approved by the VA Boston Healthcare System Institutional Review Board. Individuals provided verbal informed consent and were compensated $50.00.

Individuals from the larger Project VALOR cohort were excluded from the current analyses if they had missing data on one or more outcome variables (68 participants), had sustained a moderate or severe TBI (156 participants), or TBI severity

was unknown (113 participants). There were $N = 1,312$ participants included in the final analyses. Participants completed study procedures remotely via Internet-administered self-report questionnaires (paper-and-pencil versions were mailed upon request) and recorded phone interviews. Phone interviews assessing TBI and PTSD symptoms were conducted by doctoral-level clinicians and occurred an average of 10.84 days ($SD = 10.95$) after questionnaire completion. Participants' age and sex were extracted from the VA electronic health record system database. Race and ethnicity were obtained via self-report questionnaire. See Table 1 for additional demographic information.

Lifetime history of mTBI was assessed using structured screening questions from current TBI classification standards from the American Congress of Rehabilitation Medicine Head Injury Interdisciplinary Special Interest Group (1993) and the VA and the U.S. Department of Defense (Management of Concussion/mTBI Working Group, 2009). Participants were asked whether they had ever sustained a head injury or blast exposure that had led to altered consciousness, memory loss, seizures, or brain surgery. Individuals endorsing at least one of these symptoms were questioned about a maximum of five worst possible head injuries that they had experienced. Questions regarding when the injury occurred, the presence and duration of LOC, posttraumatic amnesia (PTA), and the presence of altered mental status (AMS; i.e., dazed, confused, or seeing stars) were used to determine TBI severity. We defined mTBI as a head injury with LOC enduring 30 minutes or less, AMS immediately after the injury or after regaining consciousness, or PTA enduring 24 hours or less. This interview has demonstrated high interrater reliability for the presence of a lifetime TBI ($\kappa = .97$), and TBI characteristics (the presence and length of LOC and PTA; $\kappa = 1.00, 1.00, 1.00,$ and 0.95, respectively; Alosco et al., 2015). All TBI assessments were audio recorded, and a random subset ($n = 100$) was coded for interrater agreement on the presence or absence of a TBI ($\kappa = .97$).

Assessment of PCS was based on the VA TBI Clinical Reminder and Screening Tool (U.S. Department of Veterans Affairs, 2010). Participants were categorized as experiencing PCS if they endorsed any of the following symptoms beginning or worsening after their worst mTBI and also during the past week: memory problems/lapses, balance problems or dizziness, sensitivity to bright light, irritability, headache, or sleep problems.

The Structured Clinical Interview for DSM-IV, PTSD module (SCID-IV; Spitzer, Williams, Gibbon, & First, 1992) was used to make a current (past month) PTSD diagnosis based on criteria according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; American Psychiatric Association, 2000). Interrater agreement, based on a review of the interview recording ($n = 54$), was high ($\kappa = .91$).

Participants completed an abbreviated version of the Prime-MD Patient Health Questionnaire (PHQ; Spitzer, Kroenke, & Williams, 1999), which included assessment of symptoms of depression, pain/physical complaints, and anxiety. Current

Table 1
Characteristics of Total Sample and Differences by Sex

Variable	Male (n = 619)		Female (n = 693)		Combined (N = 1,312)		χ^2 or t
	n or M	*% or SD*	*n or M*	*% or SD*	*N or M*	*% or SD*	
Age (years)	37.64	10.11	36.62	9.47	37.10	9.79	1.89
PHQ-9 total	20.19	6.45	19.76	6.34	19.97	6.3	1.21
IPF total	41.53	15.59	40.39	15.47	40.93	15.53	1.32
Race							46.11[***]
Hispanic	76	12.3	94	13.6	170	13.0	0.48
White	462	74.6	411	59.3	873	66.5	34.51[***]
Black	56	9.1	149	21.5	205	15.6	38.47[***]
Other	25	4.0	39	5.6	64	4.9	1.78
mTBI							87.10[***]
mTBI	169	27.3	130	18.8	299	22.8	13.56[***]
mTBI with LOC	202	32.6	111	16.0	313	23.9	49.69[***]
No mTBI	248	40.1	452	65.2	700	53.4	83.16[***]
TBI count							98.27[***]
1	180	29.1	155	22.4	335	25.6	7.75[**]
> 1	191	30.9	85	12.3	276	21.1	68.03[***]
Time of TBI							
Deployment	190	30.7	93	13.4	283	21.6	57.67[***]
All other	104	16.8	116	16.7	220	16.8	0.00
Both	77	12.4	31	4.5	108	8.2	27.47[***]
Major depression	248	40.1	257	37.1	505	38.5	1.23
Current PTSD	330	53.3	351	50.6	681	51.9	0.93
PTSD and depression	200	32.3	205	29.6	405	30.9	148.58[***]
Back pain	506	82.8	538	78.3	1044	80.4	4.17[**]
Body/joint pain	528	85.9	555	80.3	1083	82.9	7.04[**]
Headache	454	73.6	557	80.6	1011	77.3	9.17[**]
Any pain	600	96.9	672	97.0	1272	97.0	0.00
Pain areas							1.02
0	19	3.1	21	3.0	40	3.1	
1	66	10.7	86	12.4	152	11.6	
2	180	29.1	194	28.0	374	28.5	
3	354	57.2	392	56.6	746	56.9	
Pain severity							8.39
0	19	3.1	21	3.0	40	3.1	
1	45	7.3	66	9.5	111	8.5	
2	88	14.2	93	13.4	181	13.8	
3	136	22.0	133	19.2	269	20.5	
4	139	22.5	147	21.2	286	21.8	
5	125	20.2	129	18.6	254	19.4	
6	67	10.8	104	15.0	171	13.0	

Note. IPF = Inventory of Psychosocial Functioning; LOC = loss of consciousness; mTBI = mild traumatic brain injury; TBI = traumatic brain injury; PHQ = Prime-MD Patient Health Questionnaire; PTSD = posttraumatic stress disorder.
[**]$p < .01$. [***]$p < .001$.

analyses only included items assessing pain and depression. Total pain severity over the previous 4 weeks was calculated by summing ratings of back, body/joint, and headache pain (0 = *not bothered*, 1 = *bothered a little*, 2 = *bothered a lot*). Pain severity scores ranged from 0 to 6.

We used nine PHQ items to establish a diagnosis of probable major depression. Participants were asked how frequently they were bothered by the following problems over the past 2 weeks (0 = *not at all*, 4 = *nearly every day*): (a) little interest or pleasure in doing things; (b) feeling down, depressed, or hopeless;

(c) changes in sleep or eating habits; (d) decreased energy; (e) feeling worthless or like a failure; (f) trouble concentrating; (g) psychomotor slowing or being fidgety; (h) or thoughts of death. Individuals endorsing little interest or pleasure in doing things or depressed mood, plus five additional symptoms, at least more than half of the days during the past 2 weeks, met criteria for probable major depression. A total PHQ depression score was calculated by summing the frequency of symptoms endorsed; the highest possible score was 36.

Psychosocial functioning was measured with the Inventory of Psychosocial Functioning (IPF; Marx et al., 2009; Rodriguez, Holowka, & Marx, 2012), a multifaceted measure of functioning, which, unlike most other measures of functional impairment, does not confound functioning with symptomatology or require respondents to make attributions about the etiology of functional impairments (see Holowka & Marx, 2012). The IPF is an 80-item self-report measure used to assess functional impairment across multiple psychosocial domains of functioning within the last 30 days. Participants rate items on a 7-point scale ($0 = never$, $6 = always$) and higher scores reflect greater impairment. The IPF yields an overall functional impairment score, computed by summing all completed items, dividing by the maximum possible score, and multiplying by 100 (Marx et al., 2009; Rodriguez et al., 2012). Possible scores range from 0 to 100. The following empirically derived cut scores, reflecting functional impairment severity, were used (Marx, 2013): $0–10 = no\ impairment$, $11–30 = mild\ impairment$, $31–50 = moderate\ impairment$, $51–80 = severe\ impairment$, and $81–100 = extreme\ impairment$. Correlations with other self-report and interview measures of functional impairment and internal consistency of the full IPF are excellent (Cronbach $\alpha = .93$; Marx et al., 2015; Rodriguez et al., 2012). Marx et al. (2015) also showed that the IPF is a strong indicator of a latent functioning variable. Internal consistency within the current sample was .78.

Data Analysis

Statistical analyses were completed using SPSS 20.0. We summarized the data to determine the racial/ethnic make-up of the participant sample, as well as the number of participants with a TBI history, PTSD, depression, and chronic pain. We then conducted chi-square analyses to determine whether there were any sex differences on these variables. Using an analysis of variance, we (ANOVA) planned to examine group differences in psychosocial functioning (IPF scores) between four diagnostic groups we formed: mTBI + PTSD, mTBI only, PTSD only, neither diagnosis using an analysis of variance (ANOVA). We then adjusted for age, race/ethnicity, major depression, and pain severity in a subsequent analysis of covariance (ANCOVA), as these are conditions commonly reported among OEF/OIF veterans (Hoge et al., 2008; Romesser, Booth, Benge, Pastorek, & Helmer, 2012) and known to affect functioning (Bergman, 2005; Raggi et al., 2012). Post hoc group comparisons between

IPF scores were conducted using a least significant difference adjustment.

To examine the potential association between LOC and functioning, we compared the overall IPF score between individuals with and without LOC, adjusting for age, race/ethnicity, pain severity, major depression, and PTSD. We completed two additional comparisons of IPF scores between individuals with a history of a single versus multiple mTBIs, and individuals with and without PCS, adjusting for age, race/ethnicity, pain severity, major depression, and PTSD. Twenty participants did not have an identified worst mTBI; they were not included in exploratory analyses of PCS.

Results

More men than women reported a history of mTBI, $\chi^2(1, N = 1,312) = 83.16$, $p < .001$, $\varphi = .25$ (medium effect size [ES]), mTBI with LOC, $\chi^2(1, N = 1,312) = 49.69$, $p < .001$, $\varphi = .20$ (medium ES), and multiple mTBIs, $\chi^2(1, N = 1,312) = 68.03$, $p < .001$, $\varphi = .23$ (medium ES; see Table 1). Among individuals with multiple prior mTBIs, there was no significant difference between males (40.3%) and females (36.5%) who sustained at least one mTBI during and outside of deployment, $\chi^2(1, N = 276) = 0.37$, $p = .546$, $\varphi = .04$. Significantly more males, however, sustained multiple mTBIs during deployment only, $\chi^2(1, N = 276) = 9.04$, $p = .003$, $\varphi = .18$ (small–medium ES). In contrast, more females reported sustaining mTBIs outside of deployment, $\chi^2(1, N = 276) = 16.52$, $p < .001$, $\varphi = -.25$ (see Table 1 for mean values for both sexes and the entire sample).

There were 46.3% of males and 47.5% of females who met criteria to establish the presence of PCS, $\chi^2(1, N = 592) = 0.07$, $p = .791$, $\varphi = -.01$. More individuals with a history of mTBI and current PTSD met criteria to establish the presence of PCS, compared to individuals with a history of mTBI alone, $\chi^2(1, N = 592) = 29.21$, $p < .001$, $\varphi = -.22$. There were no sex differences in PCS in either diagnostic group (Table 2).

Just over half of participants (51.9%) met diagnostic criteria for current PTSD, and 38.5% met criteria for probable major depression. There were no significant sex differences in current PTSD or probable major depression diagnoses, number of pain areas (out of three possible areas: back, body/joint, and head), total pain severity (out of a maximum score of 6), or IPF scores. The mean score on the IPF for the entire sample was 40.93 ($SD = 15.53$), reflecting moderate functional impairment. IPF scores were significantly associated with total PHQ depression score ($r = .66$, $p < .001$) and pain severity scores ($r = .31$, $p < .001$).

Significant diagnostic group differences in IPF scores were observed for both sexes: males, $F(3, 615) = 33.17$, $p < .001$, $\eta^2_p = .14$; females, $F(3, 689) = 56.53$, $p < .001$, $\eta^2_p = .20$. Post hoc comparisons revealed that individuals with PTSD, with or without a history of mTBI, reported significantly worse psychosocial functioning compared to individuals with

Table 2
Rates of Postconcussive Symptoms by Sex Within Diagnostic Group

	mTBI/PTSD				mTBI Only			
	Male (n = 237)		Female (n = 147)		Male (n = 119)		Female (n = 89)	
Variable	*n*	%	*n*	%	*n*	%	*n*	%
Memory problems	79	33.3	48	32.7	17	14.3	10	11.2
Balance problems/dizziness	47	19.8	39	26.5	7	5.9	6	6.7
Headaches	89	37.6	62	42.2	26	21.8	19	21.3
Light sensitivity	72	30.4	46	31.3	12	10.1	12	13.5
Irritability	94	39.7	56	38.1	25	21.0	16	18.0
Sleep problems	95	40.1	57	38.8	25	21.0	15	16.9

Note. $N = 592$. mTBI = mild traumatic brain injury; PTSD = posttraumatic stress disorder.

mTBI alone or neither mTBI nor PTSD ($ps < .001$). No other significant differences for diagnostic group emerged.

We also conducted ANCOVAs, adjusting for age, race/ethnicity, and pain severity. As the presence of probable major depression differed between diagnostic groups, we conducted separate ANCOVAs comparing individuals with and without depression (homogeneity of slopes was assessed for each covariate; all resulting interaction terms were nonsignificant). Prior to separating by depression, significant between-diagnostic group differences were observed for both sexes: males, $F(3, 612) = 25.09$, $p < .001$, $\eta^2_p = .11$; females, $F(3, 686) = 38.44$, $p < .001$, $\eta^2_p = .14$ (Table 3). Diagnostic group findings remained consistent with ANOVA findings. After separating by sex and depression, males and females with major depression endorsed greater psychosocial impairment compared with those without depression, regardless of diagnostic group (Table 4).

Prior LOC, adjusted for age, race/ethnicity, pain severity, and major depression (homogeneity of slopes was assessed for each covariate; all resulting interaction terms were nonsignificant), was not significantly associated with psychosocial function-

ing across the sample, $F(1, 606) = 0.85$, $p = .358$, $\eta^2_p < .01$, or by sex: males, $F(1, 365) = 0.83$, $p = .361$ $\eta^2_p < .01$; females, $F(1, 235) = 0.18$, $p = .669$, $\eta^2_p < .01$. There was a significant interaction between PTSD and LOC, $F(1, 608) = 5.55$, $p = .019$, $\eta^2_p < .01$. Consequently, we conducted two separate ANCOVAS, separating by current PTSD diagnosis, to examine potential associations between presence of LOC and functional impairment, adjusting for age, race/ethnicity, pain severity, and major depression. Findings indicated no significant association between LOC and functional impairment.

History of multiple mTBIs, adjusted for age, race/ethnicity, pain severity, major depression, and current PTSD (homogeneity of regression slopes was assessed and all resulting interaction terms were nonsignificant), was also not significantly associated with IPF score, $F(1, 604) = 0.02$, $p = .889$, $\eta^2_p < .01$, nor were there sex differences: males, $F(1, 364) = 0.38$, $p = .540$, $\eta^2_p < .01$; females, $F(1, 233) = 1.09$, $p = .297$, $\eta^2_p < .01$. PCS, adjusted for age, race/ethnicity, pain severity, major depression, and current PTSD (homogeneity of regression slopes was assessed and all resulting interaction

Table 3
Adjusted Post Hoc Comparisons Between Diagnostic Groups for IPF Total Score

	Adjusted *M*		SE		*M* difference		SE	
PTSD/mTBI group	Male	Female	Male	Female	Male	Female	Male	Female
mTBI + PTSD	45.35[a]	44.60[b]	0.92	1.10	–	–		
PTSD	45.89[c]	45.61[d]	1.24	0.86	−0.54	−1.02	1.55	1.39
mTBI	35.25[e]	35.67[f]	1.29	1.41	10.10[***]	8.93[***]	1.59	1.79
Neither	34.97[g]	33.12[h]	1.34	0.95	10.38[***]	11.48[***]	1.66	1.48

Note. Total $N = 1{,}312$, male $n = 619$, female $n = 693$, reference group = mTBI/PTSD group. Means adjusted for age, race/ethnicity, and severity of pain. Mean difference was *M* of reference group – *M* of comparison group. PTSD = posttraumatic stress disorder; mTBI = mild traumatic brain injury; IPF = Inventory of Psychosocial Functioning.
[a]$n = 249$. [b]$n = 150$. [c]$n = 132$. [d]$n = 247$. [e]$n = 122$. [f]$n = 91$. [g]$n = 116$. [h]$n = 205$.
[***]$p < .001$.

Table 4
Comparisons of IPF Total Within Diagnostic Status of Major Depression Separately by Sex

	mTBI/PTSD ($n = 399$)				PTSD ($n = 379$)				mTBI ($n = 213$)				Neither ($n = 321$)				
DEP	M_{Adj}	SE	M_D	SE	M_{Adj}	SE	M_D	SE	M_{Adj}	SE	M_D	SE	M_{Adj}	SE	M_D	SE	η^2_p
								Male									
Y	53.66[a]	1.13	–	–	52.29[b]	1.72	1.36	2.07	53.33[c]	2.94	0.33	3.16	44.53[d]	2.57	9.13	2.82**	.42*
N	36.65[e]	1.15	–	–	40.48[f]	1.39	−3.83	1.81*	30.79[g]	1.18	5.86	1.65***	30.57[h]	1.28	6.09	1.77**	.10***
								Fem									
Y	51.05[i]	1.46	–	–	52.69[j]	1.18	−1.64	1.89	47.87[k]	3.18	3.19	3.50	45.32[l]	2.24	5.73	2.70*	.04*
N	38.55[m]	1.45	–	–	39.67[n]	1.09	−1.12	1.80	31.97[o]	1.39	6.59	2.00**	29.51[p]	0.92	9.04	1.73***	.12***

Note. Total $N = 1,312$, male $n = 619$, female $n = 693$. Means adjusted for age, race/ethnicity, and severity of pain. mTBI = mild traumatic brain injury; PTSD = posttraumatic stress disorder; M_{Adj} = adjusted mean; M_D = mean difference (mean of reference group – mean of comparison group); IPF, Inventory of Psychosocial Functioning.
[a]$n= 139$. [b]$n = 61$. [c]$n = 21$. [d]$n = 27$. [e]$n = 110$. [f]$n = 71$. [g]$n = 101$. [h]$n = 89$. [i]$n = 82$. [j]$n = 123$. [k]$n = 17$. [l]$n = 35$. [m]$n = 68$. [n]$n = 124$. [o]$n = 74$. [p]$n = 170$.
*$p < .05$. **$p < .01$. ***$p < .001$.

terms were nonsignificant), was not significantly associated with IPF score among individuals with a history of mTBI and PTSD, $F(1, 378) = 0.02$, $p = .890$, $\eta^2_p < .01$, or a history of mTBI alone, $F(1, 202) = 0.45$, $p = .503$, $\eta^2_p < .01$.

Discussion

This study found that individuals with PTSD, both with and without a history of mTBI, reported greater psychosocial functional impairment compared to individuals with only mTBI or neither mTBI nor PTSD. There were no significant differences in self-reported functional impairment between individuals with a history of mTBI without PTSD and individuals with neither mTBI nor PTSD. Patterns of functional impairment across diagnostic groups were similar for males and females. Probable major depression was associated with functional impairment, such that depressed individuals reported greater impairment compared with nondepressed participants, regardless of other comorbid conditions. In contrast, the severity of the mTBI as indexed by LOC, a history of multiple mTBIs, and the presence of PCS was not significantly associated with functional impairment.

Collectively, our findings suggested that PTSD was a primary contributor to functional impairment, regardless of mTBI history. These results were consistent with studies highlighting the association of PTSD, independent of mTBI, with lasting cognitive, physical, and emotional symptoms (Walker, Franke, McDonald, Sima, & Keyser-Marcus, 2015), and functional impairment (e.g., Hoge et al., 2008; Polusny et al., 2011; Vasterling et al., 2012) in veterans with mTBI history. Major depression, however, also contributed to the severity of functional impairment, such that depressed individuals reported greater impairment than nondepressed individuals. This finding was not unexpected, given the extensive literature demonstrating functional impairment among individuals with depression (Evans,

Iverson, Yatham, & Lam, 2014). To our knowledge, this study was the first to examine the association between probable major depression and functional impairment among veterans with and without a history of mTBI and/or PTSD.

The lack of a significant association in our sample between LOC and functioning, although consistent with some evidence (Hanlon, Demery, Martinovich, & Kelly, 1999), contrasted with other studies demonstrating greater psychosocial impairment among OEF/OIF veterans with mTBI with LOC (e.g., Pietrzak et al., 2009). Furthermore, the finding of an absence of an association between multiple mTBIs and functioning in this sample would be expected by most based on existing equivocal findings on the association between mTBIs and cognitive functioning, a potential proxy related to psychosocial functioning (Belanger et al., 2010). It is possible that our failure to find significant associations between LOC, multiple mTBIs, or PCS with functioning may have reflected the limited impact of mTBI on psychosocial functioning in the postacute phase, consistent with expectations for physical and cognitive recovery following mTBI (Rohling et al., 2011).

We observed similar relationships between functioning in males and females and multiple variables, including group status, LOC, single versus multiple mTBIs, and the presence of PCS. This finding was particularly interesting given that evidence of sex differences and functioning has been inconclusive (Bazarian et al., 2010; Fang et al., 2015). It may be that the VALOR sampling strategy, which resulted in a considerable number of females in each diagnostic group, allowed us to examine potential sex differences more reliably. Future work examining functioning as an outcome would likely benefit from including sufficient numbers of males and females in each diagnostic group.

Strengths of this study included the use of a national sample with equal numbers of male and female veterans, the use of standard clinical diagnostic instruments in the assessment

of PTSD, and the inclusion of a multidimensional measure of psychosocial functioning designed to assess functional impairment specific to veterans. A limitation of the current study was the requirement that participants previously obtain at least some clinical services through the VA Health Administration (VHA). Although the majority (61%) of OEF/OIF veterans have obtained some VA health care, a substantial minority have not (U.S. Department of Veterans Affairs, 2015). Veterans who use VHA services may be less likely to have private health insurance or other financial resources and may be more symptomatic than the veteran population in general. This sample was also limited to combat-exposed veterans who had undergone a mental health assessment, which may have reduced generalizability to veterans who have not been evaluated for mental health concerns. Selection factors for this study may have also resulted in underrepresentation of some variables of interest, including multiple TBIs, and multiple instances of LOC and PCS. Finally, although this study used a clinician-interview to assess mTBI, we were dependent on retrospective self-report of head injury and subsequent symptoms to establish mTBI history.

Results from the present study supported findings (Bryant et al., 2010; Pietrzak et al., 2009; Polusny et al., 2011) demonstrating the limited long-term impact of mTBI on psychosocial functioning. Although screenings for TBI in their current form may detect individuals who sustained a moderate or severe TBI, as well as yield important information regarding other physical health conditions, the systematic screening for mTBI among OEF/OIF veterans who receive VA care, which typically occurs long after the occurrence of a head injury, may not provide sufficient information about the veteran's functioning. Future efforts to include an assessment of psychosocial functioning at the time of the screening, however, may improve the identification of individuals experiencing functional impairment, resulting in enhanced treatment planning and intervention referral. In particular, further assessment and treatment for stress-related mental health conditions may have the greatest potential for improving functional outcomes, regardless of whether the individual has a history of mTBI.

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The Effect of Military Sexual Assault, Combat Exposure, Postbattle Experiences, and General Harassment on the Development of PTSD and MDD in Female OEF/OIF Veterans

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This study examined the extent to which military sexual assault (MSA) was associated with posttraumatic stress disorder (PTSD) and major depressive disorder (MDD) diagnostic status and symptom severity, while accounting for other stressor experiences (i.e., combat exposure, postbattle experiences, and general harassment) and key demographic variables. Participants were 673 female Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) veterans enrolled in the Veterans' Afterdischarge Longitudinal Registry (Project VALOR). Participants were interviewed by doctoral-level clinicians using the PTSD and MDD Modules of the Structured Clinical Interview for *DSM–5* (SCID-5) and completed self-report measures of MSA, combat exposure, postbattle experiences, general harassment, and PTSD and depression symptom severity. After controlling for demographics, combat exposure was the sole significant predictor of PTSD diagnosis (AOR = 1.07) and MSA was the sole significant predictor of MDD diagnosis (AOR = 1.30). In addition, combat exposure (β = .26) and general harassment (β = .15) were significantly associated with PTSD symptom severity, and MSA (β = .16), combat exposure (β = .20), and general harassment (β = .16) were all significant predictors of MDD symptom severity. These findings suggest that that MSA, combat exposure, and general harassment may be uniquely associated with psychopathology among female OEF/OIF veterans.

What is the significance of this article for the general public?
This study suggests that combat exposure is the strongest predictor of PTSD diagnostic status and symptom severity while MSA is the strongest predictor for MDD diagnostic status and symptom severity in a sample of female OEF/OIF veterans. Additionally, it highlights the importance of assessing all deployment-related stressors such as MSA, combat exposure, postbattle experiences, and general harassment in female veterans.

Keywords: military sexual assault (MSA), posttraumatic stress disorder (PTSD), depression, combat, deployment

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The Department of Veterans Affairs (VA) defines military sexual trauma (MST) as any sexual harassment or sexual assault experience that occurred during military service (Kimerling et al., 2010). Although both sexual harassment and sexual assault may result in various negative outcomes for military service members and veterans, these experiences are qualitatively different. Of the two, only military sexual assault (defined as intentional sexual contact characterized by the use of force, threats, intimidation, or abuse of authority or when the survivor does not or cannot consent that has occurred at any point during active duty military service; Department of Defense, 2015) fulfills the stressor criterion of the posttraumatic stress disorder (PTSD) diagnosis in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM–5*; American Psychiatric Association, 2013). As a result, only military sexual assault (MSA) can potentially lead to a PTSD diagnosis among survivors.

Prior research has shown that MSA prevalence is high, especially among female veterans deployed in support of Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF; Kimerling et al., 2010). Consistent with the notion that MSA fulfills the PTSD stressor criterion, research also has shown that female veterans who have experienced MSA report significantly more severe symptoms of PTSD and major depressive disorder (MDD; Street, Stafford, Mahan, & Hendricks, 2008; Yaeger, Himmelfarb, Cammack, & Mintz, 2006) as well higher rates of PTSD and MDD diagnoses (Street et al., 2008) than those with no sexual assault history.

Although MSA may be an important risk factor for PTSD and other trauma-related psychopathology in female veterans, other military-related stressors may also increase risk for these outcomes among these veterans. Specifically, deployment-related stressors such as combat exposure (e.g., taking sniper fire) and postbattle experiences (e.g., handling human remains) are established risk factors for developing PTSD and MDD in both male and female veterans (Henschel & McDevitt-Murphy, 2016; Pietrzak, Whealin, Stotzer, Goldstein, & Southwick, 2011; Vogt, Pless, King, & King, 2005; Vogt et al., 2011). In addition, general harassment (intentional behavior which is threatening or disturbing), although not frequently examined in extant literature, has been associated with higher rates of PTSD, particularly in female veterans (Street et al., 2008). Because PTSD and MDD are often comorbid subsequent to a traumatic event (Keane, Taylor, & Penk, 1997; O'Donnell, Creamer, & Pattison, 2004) and may be part of the same general traumatic stress construct (O'Donnell et al., 2004), general harassment may confer risk for MDD as well.

Importantly, whereas most research has established that each of these factors (MSA, deployment-related stressors, and general harassment) is associated with trauma-related psychopathology in isolation, only a few available studies have examined the extent to which these predictors are associated with PTSD and MDD in female OEF/OIF veterans when they are included in the same model. In one of the few studies that did examine some of these variables together, Dutra and colleagues (2010) identified MST as a unique predictor of self-reported PTSD and MDD symptoms in a sample of 54 active duty women deployed during OIF, above and beyond combat exposure. However, the study did not break up MST into its component parts, making it unclear what role MSA played in this association. In addition, the study left out other potentially important stressor exposures (e.g., postbattle experiences, general harassment), was underpowered, and did not control for potentially important demographics. Unfortunately, other available studies (e.g., Katz, Cojucar, Beheshti, Nakamura, & Murray, 2012; Street, Gradus, Giasson, Vogt, & Resick, 2013) share similar methodological limitations. As a result, the aforementioned studies do not allow us to obtain a clear understanding of the degree to which MSA is associated with PTSD and MDD when included in the context of other military-related stressors and demographic factors. Understanding this is essential because it may allow us to identify which individuals are at risk for these adverse outcomes. This information can assist in the development of both preventative programs which can target at-risk individuals, and treatment interventions that will assist those that have been affected. This is of particular importance for female OEF/OIF veterans who were deployed in record numbers and are now seeking care within the VA (Kimerling et al., 2010). Determining whether the risk factors identified among (mostly male) veterans apply to this subset of

female veterans will ensure we can provide these veterans with the best possible care.

This study examined how MSA was associated with PTSD and MDD diagnostic status and symptom severity in a large sample of combat-exposed female OEF/OIF veterans, while accounting for other stressor experiences (i.e., combat exposure, postbattle experiences, and general harassment) and key demographic variables. We hypothesized that each of the factors would still be significantly associated with PTSD and MDD diagnostic status and symptom severity, even after controlling for the other stressors and demographic characteristics. Because limited research to date has examined any of these factors concurrently, and no literature has yet examined how all of these factors perform when considered together, we had no a priori hypotheses about whether there would emerge a factor or factors that demonstrated superior predictive ability, and if so, which factor(s) that might be.

Method

Participants

Participants were female veterans enrolled in the Veterans After-Discharge Longitudinal Registry (Project VALOR), a longitudinal national registry of Iraq and Afghanistan veterans (Rosen et al., 2012). In an effort to recruit combat-exposed veterans, Project VALOR recruited from the two branches of the military that have historically been deployed to combat operations: the Army and Marine Corps (Baker et al., 2009). To be included in Project VALOR, veterans must have undergone a mental health evaluation at a VA facility. Veterans with probable PTSD according to VA medical records (at least two instances of a PTSD diagnosis by a mental health professional associated with two separate visits) were oversampled to create a 3:1 (probable PTSD: no PTSD) ratio, and females (underrepresented in veteran populations) were oversampled to create a 1:1 (female:male) ratio. Potential Project VALOR participants were recruited from a roster of veterans who met inclusion criteria. The roster was provided by the VA Environmental Epidemiology Service. Potential participants ($n = 4,331$) were contacted by phone. Of these, 2,712 (62.6%) consented to participate. Of consented participants, 2,169

(80.0%) completed questionnaires and 1,649 (60.8%) completed both questionnaires and a diagnostic interview.

From the initial dataset of 1,649 veterans, 822 identified as female. One-hundred and 48 of these female veterans were excluded from the current analyses because they did not complete the required measures. Participants in the current study ($n = 673$) did not differ from individuals excluded due to missing data ($n = 149$) on employment status, education level, marital status, or PTSD or MDD diagnostic status (all χ^2s < 1.73; all ps > .05), or on age or PTSD or MDD symptom severity (all ts < 1.32; all ps > .05). However, individuals who identified as non-White were less likely to be represented in the sample, ($\chi^2 = 4.44$; $p < .05$). In the final sample, study participants had an average age of 36.9 years ($SD = 9.6$ years), were primarily White (74.3%), and were currently married or living with a partner (50.1%). Forty-seven percent of study participants were employed at the time of data collection, and 50.6% reported having a college degree or higher (see Table 1 for participant characteristics). Because participants did not differ by military branch on any key demographic variables, PTSD and MDD diagnoses (all χ^2s < 75.63; all ps > .34), deployment stressor scores, or PTSD and MDD symptom severity scores (all ts < 1.39; all ps > .08), both braches were collapsed into a single sample for the purpose of data analysis.

Measures

Demographic information. Self-report questionnaires were used to collect information on participant age, race, gender, education, employment, and marital status.

MSA. The sexual harassment scale from the second version of the Deployment Risk and Resilience Inventory (DRRI-2; Vogt, Smith, King, & King, 2012) was used to assess MSA. Three items were selected from the larger sexual harassment scale that assessed threat of assault, attempted rape, and completed rape. Items were rated on a 4-point scale, ranging from 1 (*never*) to 4 (*many times*). Items were summed to yield a total scale score (with higher scores indicating greater MSA severity), with total scores ranging from 3 to 12. Participants who scored 4 or greater on the MSA scale were considered to have experienced MSA. Although

Table 1
Descriptive Characteristics of Study Participants (n = 673)

Variable	M (SD) or %	Range
Demographic characteristics		
Race/Ethnicity		
Black	23.5	—
Hispanic	13.9	—
White	74.3	—
Asian	2.8	—
Other/Unknown	.7	—
Education		
High school or equivalent	4.0	—
Some post-high school	45.4	—
College degree or higher	50.6	—
Employed	46.9	—
Married or living with a partner	50.1	—
Key predictor variables		
DRRI-2 MSA total score	7.3 (1.99)	3–12
DRRI Combat Experiences total score	43.84 (7.12)	16–64
DRRI Aftermath of Battle total score	21.32 (5.60)	16–80
DRRI-2 General Harassment total score	27.35 (5.61)	8–24
Outcome variables		
SCID-5 PTSD Diagnosis	62.7%	—
SCID-5 MDD Diagnosis	26.4%	—
PCL-5 PTSD Symptom Severity	39.6 (20.1)	0–80
PHQ-9 MDD Symptom Severity	12.7 (6.8)	0–27

Note. DRRI = Deployment Risk and Resilience Inventory; MSA = military sexual assault; SCID-5 = Structured Clinical Interview for *DSM-5*; PTSD = posttraumatic stress disorder; MDD = major depressive disorder; PCL-5 = PTSD Checklist for *DSM-5*; PHQ-9 = Patient Health Questionnaire–depression module.

our modified version has not been used previously, the sexual harassment scale has demonstrated strong internal consistency reliability ($\alpha = .86$) and criterion-related validity in past studies (e.g., Vogt et al., 2013). In the current study, the modified MSA scale scores demonstrated good reliability ($\alpha = .84$).

Combat exposure. Combat exposure was assessed using the 16-item combat experiences scale from the DRRI (King, King, Vogt, Knight, & Samper, 2006). Items were rated on a 5-point scale, ranging from 1 (*never*) to 5 (*daily or almost daily*). Items were summed to yield a total scale score with higher scores indicating greater combat exposure severity. Total scores ranged from 16 to 80. Participants who scored 17 or greater on the combat exposure scale were considered to have experienced combat during deployment; this cutoff score is consistent with past research (e.g., Street et al., 2013). In previous research, mental and physical health measures were used to demonstrate criterion-related validity in the DRRI, and researchers have

found the internal consistency to be strong, and found high internal consistency reliability when examining the combat subscale ($\alpha = .90$; Vogt, Proctor, King, King, & Vasterling, 2008). Additionally, Vogt et al. (2008) found evidence for high discriminative validity between the subscales of the DRRI. In the current study, the combat experiences scale scores had excellent reliability ($\alpha = .91$).

Postbattle experiences. Postbattle experiences, including handling human remains and witnessing human suffering, were assessed using the 16-item aftermath of battle scale of the DRRI (King et al., 2006). Items were rated on a 6-point scale ranging from 1 (*never*) to 5 (*daily or almost daily).* Items were summed to yield a total scale score with higher scores indicating greater severity of postbattle experiences. Total scores ranged from 16 to 80. Consistent with past literature (e.g., Street et al., 2013), participants who scored 17 or greater on the aftermath of battle scale were considered to have endured postbattle experiences during deployment.

Previous research demonstrated criterion-related validity in the DRRI, and have found the internal consistency for the aftermath of battle scale to be strong ($\alpha = .90$; Vogt et al., 2008). In the current study, the aftermath of battle scale scores demonstrated excellent reliability ($\alpha = .92$).

General harassment. General harassment (e.g., harassment on the basis of gender or racial group membership), was assessed using the 8-item general harassment scale of the DRRI-2 (Vogt et al., 2013). Items were rated on a 4-point scale ranging from 1 (*never*) to 4 (*many times*). Items are summed to yield a total scale score with higher scores indicating greater severity of harassment, with total scores ranging from 8 to 24. Participants who scored 9 or greater on the general harassment scale were considered to have experienced general harassment (Street et al., 2013). Previous research has found the general harassment subscale of the DRRI-2 to have high internal consistency reliability ($\alpha = .93$; Vogt, et al., 2013). Additionally, Vogt et al. (2013) found all DRRI-2 subscales, including general harassment, had high discriminant validity. In the current study, the general harassment scale scores had excellent reliability ($\alpha = .93$).

PTSD diagnostic status. PTSD diagnostic status was assessed using the PTSD module of the Structured Clinical Interview for *DSM–5* (SCID-5; First, Williams, Karg, & Spitzer, 2015), a semistructured interview that corresponds to the *DSM–5* PTSD diagnosis. Doctoral-level clinicians assessed for current (past 30 days) PTSD over the telephone, and the *DSM–5* algorithm was used to calculate *DSM–5* PTSD diagnostic status. A random subset of interviews were coded for interrater agreement on the PTSD module ($n = 100$), and interrater reliability was excellent ($\kappa = .82$).

MDD diagnostic status. MDD diagnostic status was assessed using the MDD module of the SCID-5 (First et al., 2015). Like the PTSD module, the MDD module corresponds to the *DSM–5* MDD diagnosis. In the current study, doctoral-level clinicians assessed for current (past 30 days) MDD over the telephone, and the *DSM–5* algorithm was used to calculate *DSM–5* MDD diagnostic status. Again, a random subset of interviews were coded for agreement on the MDD module ($n = 100$), and interrater reliability was excellent ($\kappa = .75$).

PTSD symptom severity. PTSD symptom severity was measured by the PTSD Checklist for *DSM–5* (PCL-5; Weathers et al., 2013). The PCL-5 is a 20-item self-report measure which corresponds to the *DSM–5* PTSD diagnosis. Items are rated on a 5-point ordinal scale ranging from 0 (*not at all*) to 4 (*extremely*). Higher scores indicate greater PTSD symptom severity, with total scores ranging from 0 to 80. Previous research has found PCL-5 scores to demonstrate that the scale had convergent and discriminant validity, as well as excellent internal consistency (Bovin et al., 2016). This study's PCL-5 scores had excellent reliability ($\alpha = .96$).

MDD symptom severity. Severity of MDD was assessed using the 9-item depression subscale of the Patient Health Questionnaire (PHQ-9; Spitzer, Kroenke, & Williams, 1999). Items were rated on a 4-point scale ranging from 0 (*not at all*) to 3 (*nearly every day*). Items are summed to yield a total scale score with higher scores indicating greater MDD severity, with total scores ranging from 0 to 27. The PHQ-9 has been found to be a valid and reliable tool for measuring depressive symptoms (Kroenke, Spitzer, & Williams, 2001), and current scores demonstrated excellent internal reliability ($\alpha = .90$).

Procedure

Data for the current study were collected as part of the follow-up assessment for Project VALOR. Participants completed self-report questionnaires online and were then interviewed via telephone by doctoral-level clinicians. All participants provided informed consent before participation, and the study was approved by the local Institutional Review Boards and the Human Research Protection Office of the U.S. Army Medical Research and Materiel Command.

Statistical Analyses

All analyses were conducted using SPSS version 22. Prior to conducting analyses to test our hypotheses, we first calculated means, standard deviations, and frequency of endorsement for each of the variables of interest. Additionally, bivariate correlations were conducted to examine the associations among the independent and dependent variables. To test our hypotheses, we conducted four regression analyses. First, we

performed two hierarchical logistic regressions to test the effect of DRRI-2 MSA scale scores, DRRI combat exposure scale scores, DRRI postbattle experiences scale scores, and DRRI-2 general harassment scale scores on PTSD and MDD diagnostic status, respectively, after controlling for demographic factors. Demographic variables were entered into Step 1, and DRRI-2 MSA scale scores, DRRI combat experiences scale scores, DRRI postbattle experiences scale scores, and DRRI-2 general harassment scale scores were entered into Step 2. Second, two hierarchical linear regressions were done to test the effect DRRI-2 MSA scale scores, DRRI combat experiences scale scores, DRRI postbattle experiences scale scores, and DRRI-2 general harassment scale scores on PTSD and MDD symptom severity, respectively, after controlling for demographic factors. Similar to the logistic regressions, demographic variables were entered into Step 1, and DRRI-2 MSA scale scores, DRRI combat experiences scale scores, DRRI postbattle experiences scale scores, and DRRI-2 general harassment scale scores were entered into Step 2.

Results

Results indicated that 45.7% ($n = 313$) of the sample had experienced MSA, 77.1% ($n = 528$) reported postbattle experiences, and nearly the entire sample reported combat exposure (96.3%; $n = 648$) and general harassment (95.1%; $n = 640$). According the SCID-5, 62.7% of the sample met criteria for PTSD, and 26.4% of the sample met for MDD. PTSD and MDD symptom severity were both in the moderate range (see Table 1). Bivariate correlations indicated that DRRI-2 MSA scale scores, DRRI combat experience scale scores, DRRI postbattle experiences scale scores, and DRRI-2 general harassment scale scores were significantly correlated with both PCL-5 and PHQ-9 scores. Similarly, point biserial correlations indicated that DRRI-2 MSA scale scores, DRRI combat experiences scale scores, DRRI postbattle experiences scale scores, and DRRI-2 general harassment scale scores were significantly correlated with PTSD diagnostic status. DRRI-2 MSA scale scores, DRRI postbattle experiences scale scores, and DRRI-2 general harassment scale scores were significantly correlated with MDD diagnostic status; however, DRRI combat experiences scale scores were not significantly correlated with MDD.

We first examined the effect of DRRI-2 MSA scale scores, DRRI combat experiences scale scores, DRRI postbattle experiences scale scores, and DRRI-2 general harassment scale scores on PTSD diagnostic status after controlling for demographic variables. The overall model was statistically significant ($\chi^2 = 111.08$, $p < .001$) and explained 21.0% of the variance (Nagelkerke $R^2 = .210$). DRRI combat experiences scale scores were significantly associated with PTSD diagnostic status (AOR = 1.07, $p < .001$, 95% CI [1.05–1.09]). However, DRRI-2 MSA scale scores, DRRI postbattle experiences scores, and DRRI-2 general harassment scale scores did not significantly predict of PTSD diagnostic status (all ps > .13; see Table 2).

Table 2
Logistic Regression Analysis for Variables Predicting PTSD Diagnosis

Step	Predictor	B	SE B	Walds χ^2	Exp(B)	95% CI
1	Caucasian	−.571	.208	7.536	.561**	.376–.849
	Education	−.320	.159	4.061	.704*	.531–.991
	Employment	−.427	.178	5.747	1.055	.460–.925
2	MSA	.152	.111	1.876	1.155	.937–1.45
	Combat exposure	.066	.012	33.275	1.069***	1.05–1.09
	Postbattle exp	.050	.039	1.620	1.054	.974–1.13
	General harassment	.023	.015	2.334	1.023	.994–1.05

Note. PTSD Diagnosis = posttraumatic stress disorder diagnosis as defined by the Structured Clinical Interview for *DSM-5*; MSA = military sexual assault as defined by the second version of the Deployment Risk and Resilience Inventory; Combat exposure = combat exposure as defined by the Deployment Risk and Resilience Inventory; Postbattle = postbattle experiences as defined by the Deployment Risk and Resilience Inventory; General harassment = general harassment as defined by the second version of the Deployment Risk and Resilience Inventory. Only demographic variables significantly associated with PTSD diagnosis depicted.
* $p < .05$.   ** $p < .01$.   *** $p < .001$.

Next, we examined the effect of DRRI-2 MSA scale scores, DRRI combat experiences scale scores, DRRI postbattle experiences scale scores, and DRRI-2 general harassment scale scores on MDD diagnostic status after controlling for demographic variables. The logistic regression model was statistically significant ($\chi^2 = 34.68$, $p < .001$), but explained less than 4.0% of the variance (Nagelkerke $R^2 = .036$). Results indicated that only DRRI-2 MSA scale scores were significantly associated with MDD diagnostic status (AOR = 1.30, $p < .001$, 95% CI [1.08–1.58]); DRRI combat experiences scale scores, DRRI postbattle experiences scale score and DRRI-2 general harassment scale scores were not significant predictors of MDD diagnostic status (all ps > .12; see Table 3).

We then tested the ability of DRRI-2 MSA scale scores, DRRI combat experiences scale scores, DRRI postbattle experiences scale scores, and DRRI-2 general harassment scale scores to predict PTSD symptom severity after controlling for demographic variables. The hierarchical linear regression model was statistically significant ($F = 32.49$, $p < .001$, $R^2_{\text{Adjusted}} = .27$). Both DRRI combat experiences scale scores ($\beta = .26$, $p < .001$) and DRRI-2 general harassment scale scores ($\beta = .15$, $p < .001$) were significantly associated with PTSD symptom severity, with DRRI combat experiences scale scores demonstrating a stronger effect than DRRI-2 general harassment scale scores. Consistent with findings for PTSD diagnostic status, neither DRRI-2 MSA scale scores nor DRRI postbattle experiences scale scores significantly predicted PTSD symptom severity (all ps > .06; see Table 4).

Finally, we examined the predictive ability of the four stressors on MDD symptom severity after controlling for demographic variables. This hierarchical linear regression model was statistically significant ($F = 22.86$, $p < .001$, $R^2_{\text{Adjusted}} = .21$). Results indicated that DRRI-2 MSA scale scores ($\beta = .17$, $p < .05$), DRRI combat experiences scale scores ($\beta = .20$, $p < .001$), and DRRI-2 general harassment scale scores ($\beta = .16$, $p < .001$) were all significant predictors of MDD symptom severity, with DRRI combat experiences scale scores demonstrating the strongest effect. DRRI postbattle experiences scale scores were not significantly associated with MDD symptom severity ($p = .82$; see Table 5).

Discussion

This study is the first to simultaneously examine the extent to which MSA severity, combat exposure severity, postbattle experience severity, and general harassment severity are related to PTSD and MDD in a large sample of female veterans deployed in support of OEF/OIF, after controlling for demographic factors. Our results showed that combat exposure predicted both PTSD diagnostic status and symptom severity, as well as MDD severity, and MSA predicted both MDD diagnostic status and symptom severity. Experiencing general harassment also contributed to both PTSD and MDD symptom severity.

Our findings highlight the importance of combat exposure in conferring risk for psychopathology among OEF/OIF female veterans.

Table 3
Logistic Regression Analysis for Variables Predicting MDD Diagnosis

Step	Predictor	B	SE B	Walds χ^2	Exp(B)	95% CI
1	Education	−.392	.157	6.236	.676*	.497–.919
	Married	−.551	.183	9.033	.576**	.402–.825
2	MSA	.264	.097	7.423	1.302**	1.08–1.58
	Combat exposure	.011	.009	1.456	1.011	.993–1.03
	Postbattle exp	−.060	.038	2.479	.942	.874–1.02
	General harassment	.024	.015	2.343	1.024	.993–1.06

Note. MDD Diagnosis = major depressive disorder diagnosis as defined by the Structured Clinical Interview for *DSM-5*; MSA = military sexual assault as defined by the second version of the Deployment Risk and Resilience Inventory; Combat exposure = combat exposure as defined by the Deployment Risk and Resilience Inventory; Postbattle exp = postbattle experiences as defined by the Deployment Risk and Resilience Inventory; General harassment = general harassment as defined by the second version of the Deployment Risk and Resilience Inventory. Only demographic variables significantly associated with MDD diagnosis depicted.
* $p < .05$.   ** $p < .01$.

Table 4
Hierarchical Linear Regression for MSA, Demographics Variables, and Deployment Stressors Predicting PTSD Symptoms

Step	Variable	B	SE B	β
1	Caucasian	−8.227	1.569	−.176***
	Education	−4.447	1.211	.125***
	Employment status	−5.383	1.393	−.132***
	Married/Living with partner	−4.372	1.372	−.107**
2	MSA	1.360	.734	.133
	Combat exposure	.531	.069	.258***
	Postbattle exp	.264	.283	.072
	General harassment	.431	.116	.149***

Note. PTSD symptoms = posttraumatic stress disorder symptoms as defined by the PTSD Checklist for *DSM-5*; MSA = military sexual assault as defined by the second version of the Deployment Risk and Resilience Inventory; Combat exposure = combat exposure as defined by the Deployment Risk and Resilience Inventory; Postbattle exp = postbattle experiences as defined by the Deployment Risk and Resilience Inventory; General Harassment = general harassment as defined by the second version of the Deployment Risk and Resilience Inventory. Only demographic variables significantly associated with PTSD symptoms depicted.
** $p < .01$. *** $p < .001$.

Specifically, combat exposure was associated with both PTSD diagnostic status and PTSD symptom severity. In fact, combat exposure was the only significant predictor of PTSD diagnostic status in our sample. In terms of PTSD and MDD symptom severity, combat exposure demonstrated the strongest association. The strong relations between combat exposure, PTSD diagnostic status, and both PTSD and MDD severity, which has also been observed among male veterans (Hoge et al., 2004), suggest that

as servicewomen take on greater combat roles, they may be at risk for the same negative consequences as their male counterparts.

Interestingly, despite the strong association between combat exposure and PTSD diagnostic status, symptom severity, and MDD symptom severity, combat exposure was not significantly associated with MDD diagnostic status. Although conjecture, it is possible that this lack of association is partly explained by inherent problems with our categorical diagnostic system,

Table 5
Hierarchical Linear Regression for MSA, Demographics Variables, and Deployment Stressors Predicting MDD Symptoms

Step	Variable	B	SE B	β
1	Caucasian	−2.190	.526	−.146***
	Employment	−1.904	.467	.145***
	Married/Living with partner	−1.787	.460	−.136***
	Education	−.981	.406	−.086*
2	MSA	.556	.246	.168*
	Combat exposure	.133	.023	.200***
	Postbattle exp	−.022	.095	−.018
	General harassment	.149	.039	.160***

Note. MDD symptoms = major depressive disorder symptoms as defined by the Patient Health Questionnaire-depression module; MSA = military sexual assault as defined by the second version of the Deployment Risk and Resilience Inventory; Combat exposure = combat exposure as defined by the Deployment Risk and Resilience Inventory; Postbattle exp = postbattle experiences as defined by the Deployment Risk and Resilience Inventory; General harassment = general harassment as defined by the second version of the Deployment Risk and Resilience Inventory. Only demographic variables significantly associated with MDD symptoms depicted.
* $p < .05$. *** $p < .001$.

which treats diagnoses as discrete categories instead of dimensional (or continuous) constructs. Future research is needed to further examine this possibility.

This study also demonstrated a significant association between MSA and MDD. MSA was the only significant predictor of MDD diagnostic status after controlling for combat exposure, postbattle experiences, general harassment, and demographic characteristics. MSA was also a significant predictor of MDD symptom severity. Interestingly, despite the strong association between MSA and MDD diagnostic status and severity, MSA was not associated with either PTSD diagnostic status or PTSD symptom severity. One possible explanation for these results is that MSA may not have been the PTSD index event for these veterans. Indeed, as discussed above, this sample was unique in that nearly all members had experienced combat, another Criterion A event. It is therefore possible that although many of these veterans experienced MSA, it was combat exposure, rather than the MSA experience, that served as the PTSD index event. However, our results suggest that even in cases where MSA was not the PTSD index event, it still significantly affected mental health in the form of MDD.

Our findings are consistent with past literature suggesting that general harassment can contribute to psychopathology among veterans. Our results suggested that whereas general harassment was not associated with PTSD or MDD diagnostic status, it was associated with both PTSD and MDD symptom severity. It is therefore possible that although harassment is not sufficiently stressful on its own to produce a PTSD or MDD diagnosis, it can contribute to symptom severity in the presence of other risk factors (particularly those that qualify as PTSD Criterion A stressors, e.g., MSA and combat) and should be included when assessing the extent of stressful deployment events among female veterans.

In contrast to results from other studies (e.g., Vogt et al., 2005), postbattle experiences were not associated with either PTSD or MDD. This may be due to the types of postbattle experiences female veterans endorsed. Extant literature indicates that postbattle experiences are predictive of psychopathology (Vogt et al., 2005), but not all postbattle experiences may be equally experienced by female and male veter-

ans during military deployments. Additional research is needed to examine postbattle experiences that are associated with psychopathology in female veterans to further clarify this relationship.

Findings from this study must be interpreted within the context of its limitations. Our study was cross-sectional and, as a result, we cannot address causality. Further, participants reported on past deployment events using a self-report Likert scale that has inherent limitations (e.g., central tendency bias). Finally, the current study examined female OEF/OIF Army and Marine veterans enrolled in VA health care; therefore, findings may not generalize to other branches of the military or to veterans who are not using mental health services.

Despite its limitations, this study is the first study to concurrently examine associations between MSA, deployment-related stressors, and general harassment in female OEF/OIF veterans, using diagnostic interviews and self-report measures. Our findings suggest that MSA, combat exposure, and general harassment may be associated with psychopathology among these women. Because of the detrimental effects of both of these disorders on functioning (Possemato, Wade, Andersen, & Ouimette, 2010; Shea, Vujanovic, Mansfield, Sevin, & Liu, 2010), as well as their association with other negative outcomes (e.g., suicidality; Lemaire & Graham, 2011), our findings highlight the importance of identifying the women who have experienced these stressors in an effort to intervene early. Careful assessment to determine the experience of these stressors, along with increased availability to improve access to care, is essential for identifying and treating this population. Although additional research is needed, the current study begins to highlight the areas in which targeted efforts will be most successful.

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The Influence of Veteran Race and Psychometric Testing on Veterans Affairs Posttraumatic Stress Disorder (PTSD) Disability Exam Outcomes

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This study examined the influence of veterans' race and examiners' use of psychometric testing during a Department of Veterans Affairs posttraumatic stress disorder (PTSD) disability examination on diagnostic and service connection status outcomes. Participants were 764 veterans enrolled in a national longitudinal registry. Current and lifetime PTSD diagnostic status was determined with the Structured Clinical Interview for *DSM–IV* (SCID) and was compared with PTSD diagnosis conferred upon veterans by their compensation and pension (C&P) examiners as well as with ultimate Veterans Affairs (VA) PTSD service connected status. The concordance rate between independent SCID current PTSD diagnosis and PTSD disability examination diagnosis was 70.4%, and between SCID lifetime PTSD diagnosis and PTSD disability examination diagnosis was 77.7%. Among veterans with current SCID diagnosed PTSD, Black veterans were significantly less likely than White veterans to receive a PTSD diagnosis from their C&P examiner (odds ratio [OR] = .39, *p* = .003, confidence interval [CI] = .20–.73). Among veterans without current SCID diagnosed PTSD, White veterans were significantly more likely than Black veterans to receive a PTSD diagnosis from their C&P examiner (*OR* = 4.07, *p* = .005, CI = 1.51–10.92). Splitting the sample by use of psychometric testing revealed that examinations that did not include psychometric testing demonstrated the same relation between veteran race and diagnostic concordance. However, for examinations in which psychometric testing was used, the racial disparity between SCID PTSD status and disability exam PTSD status was no longer significant. Results suggest that psychometric testing may reduce disparities in VA PTSD disability exam outcomes.

Keywords: veterans, PTSD, disability, disparities, service connection

Over the past 15 years, the number of veterans who have applied for and received posttraumatic stress disorder (PTSD) related disability compensation from the U.S. Department of Veterans Affairs (VA) has risen dramatically. For example, between 2008 and 2013, the number of veterans receiving disability compensation for PTSD rose from 467,274 to 648,992 (U.S. Department of Veterans Affairs, 2013), a 72% increase. VA disability compensation is a tax-free monetary benefit paid to veterans for service connected (SC) disabilities (i.e., those which arose during, or were worsened by, military service). To receive benefits (e.g., free health care, financial compensation) for disability related to service conditions, veterans must submit a claim to the Veterans Benefits Administration (VBA), which then gathers evidence to determine whether the condition in question is present, associated with a disability, and started or got worse as a result of military service. One major component reviewed by the VBA to make these determinations is the compensation and pension (C&P) examination. For PTSD claims, this involves an in-person clinical interview conducted by a licensed psychologist or psychiatrist. Examiners are asked to determine whether the claimant's symptoms meet the diagnostic criteria for PTSD as defined by the *Diagnostic and Statistical Manual for Mental Disorders* (*DSM*; American Psychiatric Association, 2000) and must document related changes in quality of life and psychosocial functioning (VBA, 2014). However, there is no standard methodology required to conduct the examination. Following the C&P examination, a VBA adjudication board reviews all evidence (e.g., service records, Social Security disability records, C&P examination results) and either approves or denies the provision of financial and other benefits.

As the number of PTSD disability claims began to increase, the VA Office of the Inspector General (OIG; 2005) conducted an internal investigation to determine the causes of both this unprecedented increase in claims and the notable disparities in disability payments made to veterans living in different states. A key finding of this investigation was that the accuracy of the disability rating and amount of compensation benefits paid for military SC disabilities is highly dependent upon the methodology used in disability evaluations. The report also noted that, because of the reliance upon an individual's self-report during the examination, determinations about the diagnostic status of mental health conditions (e.g., PTSD) are open to examiner interpretation. This is especially concerning because many VA PTSD disability examiners do not use evidence-based assessment methods during their examinations, even though these methods result in more complete and accurate coverage of PTSD symptoms and associated functional impairment during PTSD disability examinations (Jackson et al., 2011; Speroff et al., 2012). Concerns voiced about the accuracy and quality of the PTSD disability examination were further substantiated by a recent study by Marx and colleagues (2016) showing that the association between a PTSD diagnosis as determined by an independent evaluator using evidence-based methods and PTSD SC status is often discordant. Specifically, Marx et al. found that a significant minority of veterans who are currently receiving VA benefits for SC PTSD do not actually meet criteria for the disorder. Similarly, the authors' results indicated that a substantial number of veterans with military service-related PTSD who are sufficiently disabled by the disorder were denied these same benefits. However, Marx et al. (2016) did not examine the concordance between PTSD diagnosis determined by an independent assessor and the diagnosis made by the PTSD C&P examiner.

The VA OIG investigation also suggested that a number of other factors outside of the diagnostic criteria (e.g., veterans' age, branch of service) might impact VA disability rating outcomes. Notably, the influence of veteran racial status on these ratings was not examined. This exclusion is noteworthy, as research both prior to and since the VA OIG investigation has shown that Black veterans receive different VA care than White veterans for a wide range of conditions (Saha et al., 2008); receive less intensive treatment for PTSD specifically (Rosenheck, Fontana, & Cottrol, 1995); are less likely to receive a minimal trial of treatment in the 6 months following PTSD diagnosis (Spoont et al., 2015); are less satisfied with the quality of their PTSD disability examinations (Rosen et al., 2013); and are less likely to be service connected for PTSD, even after controlling for PTSD symptom severity and level of functional impairment (Murdoch, Hodges, Cowper, Fortier, & van Ryn, 2003). These findings suggest that veteran racial status may also influence the outcomes of VA PTSD disability examinations as well as the potential eligibility for disability compensation and other VA benefits. However, researchers have not yet examined whether veterans' race moderates the concordance between the C&P examiner's diagnosis and an independent assessor's diagnosis of PTSD, particularly in the absence of psychometric testing during the disability exam.

This study extends the previous work on this topic by examining the extent to which diagnoses rendered by PTSD C&P examiners were concordant with diagnoses determined by assessors who conducted an independent, semistructured diagnostic examination subsequent to the PTSD disability examination. In addition, we examined if veterans' race contributed to discordance between these diagnostic outcomes, and whether the use of psychometric testing by the C&P examiner moderated any association between veteran race and the degree of concordance between PTSD diagnoses rendered by C&P examiners and PTSD diagnoses rendered by independent evaluators. We hypothesized that (a) among veterans diagnosed with PTSD by an independent evaluator, Black veterans would be more likely than White veterans to be denied a PTSD diagnosis by their C&P examiner; (b) among veterans who did not meet criteria for PTSD based on an independent evaluation, White veterans would be more likely than Black veterans to be granted a PTSD diagnosis by their C&P examiner; (c) the use of psychometric testing during disability exams would moderate the association between race and concordance, such that the use of psychometric testing would reduce the racial disparity between the independent PTSD diagnosis and the C&P examiner diagnosis; (d) the C&P examiner diagnosis would be associated with SC status; and (e) race would also affect concordance between PTSD diagnosis determined by an independent evaluator and SC status.

Method

Participants

Participants were a subsample of U.S. Army or Marine veterans enrolled between 2009 and 2012 in the baseline assessment of the Veterans After-Discharge Longitudinal Registry (Project VALOR), a registry of VA mental health care users with and without PTSD who deployed in support of Operation Enduring

Freedom, Operation Iraqi Freedom, or Operation New Dawn (OEF/OIF/OND). To be included in the cohort, veterans must have undergone a mental health evaluation at a VA facility. Veterans with probable PTSD according to VA medical records (i.e., at least two instances of a PTSD diagnosis by a mental health professional associated with two separate visits) were oversampled at a 3:1 ratio. Female veterans were oversampled at a rate of 1:1 (female: male). Potential Project VALOR participants ($n = 4,331$) were contacted by phone; of these, 2,712 (62.6%) consented to participate in the Project VALOR registry. Of consented participants, 2,169 (80.0%) completed the questionnaires and 1,649 (60.8%) completed both the questionnaires and the diagnostic interview, which comprised the final Project VALOR sample.

In this study, we included participants from Project VALOR who reported a military-related trauma as their index event for the Structured Clinical Interview for *DSM–IV* (SCID), were assessed for current and lifetime PTSD diagnostic status, had documentation of a PTSD disability exam in their electronic medical records (EMRs), and reported being either Black or White. Participants reporting a different racial status were excluded from our analyses because of small cell sizes, which would have limited statistical power. Seven hundred ninety-seven participants were excluded because they did not have a documented PTSD disability exam, 15 participants were excluded because they were not assessed for current PTSD, and 73 participants were excluded because they reported being a race other than Black or White. Our final sample ($n = 764$) ranged in age from 22 to 67 years ($M = 38.2$; $SD = 9.9$) and the majority of the sample (83.9%) had completed at least some college. Fifty-five percent ($n = 422$) of participants were men. Eighty-four percent ($n = 645$) were White veterans, whereas the remaining 16% ($n = 119$) were Black veterans. Ninety-two percent ($n = 703$) served in the Army and 8% ($n = 61$) served in the Marines. Respondents who did not meet the inclusion criteria were younger ($M = 36.6$, $SD = 9.5$ for the excluded participants), $t(1644) = 3.34$, $p < .001$, and less likely to be male (45.4% of the excluded participants; $\chi^2 = 15.79$, $p < .001$).

Procedure

Participants provided informed consent verbally over the telephone in accordance with the research protocol approved by all local Institutional Review Boards and the Human Research Protection Office of the U.S. Army Medical Research and Material Command. After receiving verbal consent, study staff scheduled the telephone interview and reminded the participant to complete the self-administered questionnaires online. Participants were compensated $50 for their participation in the study.

Measures

Independent evaluation of PTSD diagnostic status. Trained, doctoral-level diagnosticians assessed current (past month) and lifetime PTSD via telephone using the PTSD Module of the Structured Clinical Interview for *DSM–IV* (SCID; First, Spitzer, Gibbon, & Williams, 2002). The SCID is a semistructured interview that assesses diagnoses associated with *DSM–IV*. Data collected with the PTSD SCID module has demonstrated good psychometric properties in veteran samples (Kulka et al., 1988).

Interviewers were blind to PTSD disability exam outcomes, PTSD SC status, and participant race. Throughout the study, we held regular meetings with assessment personnel during which cases were discussed to ensure diagnostic reliability and to prevent rater drift. Interrater reliability for SCID interview data, computed based on a randomly selected subsample ($n = 54$), was excellent ($\kappa = .91$). SCID PTSD diagnostic status was the independent standard to which both C&P examiner PTSD diagnosis and PTSD SC status were compared.

PTSD disability exams and SC status. Trained research assistants collected C&P examiner-determined diagnoses and information on the use of psychometric testing by accessing the C&P section, the progress notes section, and the health summaries section of participants' EMRs. When multiple PTSD C&P exams were found in the EMR, we compared the C&P exams that were most proximal to our PTSD assessment, regardless of whether or not they were initial or review C&P exams, to minimize the possibility that any discrepancies would be due to change in diagnostic status over time. The mean time between disability exams and the Project VALOR assessment was 22.11 months ($SD = 18.35$). Research assistants also collected PTSD SC status information by accessing the disabilities section of participants' EMRs. These data were abstracted concurrently with the collection of Project VALOR self-report questionnaire and interview data.

Demographics. Participants completed a self-report questionnaire that gathered information about participant age, race, gender, education, and income.

Deployment Risk and Resilience Inventory. The Deployment Risk and Resilience Inventory (DRRI; King, King, Vogt, Knight, & Samper, 2006) is a collection of scales that assess combat-related factors associated with mental health conditions noted in veteran populations. DRRI scores have shown good internal consistency and satisfactory reliability among samples of Gulf War and Operation Iraqi Freedom veterans (Vogt, Proctor, King, King, & Vasterling, 2008). To assess combat exposure, the Combat Experiences subscale of the DRRI was included in the self-administered questionnaire.

Data Analysis Plan

We conducted three sets of analyses to examine the association between C&P examiner PTSD diagnosis and SCID PTSD diagnosis. First, we calculated 2×2 contingency tables to examine both the overall concordance between C&P examiner PTSD diagnosis and SCID PTSD diagnosis and the directionality of concordance/discordance. Participants were classified into four possible outcomes in these concordance analyses as (a) true positives (C&P examiner PTSD diagnosis is Yes and SCID PTSD diagnosis is Yes), (b) false negatives (C&P examiner PTSD diagnosis is No and SCID PTSD diagnosis is Yes), (c) false positives (C&P examiner PTSD diagnosis is Yes and SCID PTSD diagnosis is No), and (d) true negatives (C&P examiner PTSD diagnosis is No and SCID PTSD diagnosis is No). Overall concordance was calculated by summing the true positives and true negatives and discordance was calculated by summing the false positives and false negatives. In these initial analyses, we examined both current and lifetime diagnostic SCID PTSD status compared with C&P examiner PTSD status. Given that current PTSD symptoms, distress, and functional impairment are the typical focus of VA PTSD disability examinations and PTSD service connection decisions, we focused our primary analyses on comparing disability exami-

nation and service connection outcomes with current SCID PTSD diagnostic status. However, in an attempt to account for any discrepancies in diagnostic outcomes that might be unrelated to any of our variables of interest, we reran all analyses using lifetime SCID PTSD diagnostic status, instead of current SCID PTSD diagnostic status.

Next, we examined the effect of race on three different aspects of concordance/discordance. First, we examined whether Black veterans demonstrated significantly different patterns of overall concordance/discordance than White veterans. This was conducted as an omnibus test to see if differences appeared prior to examining the components of concordance. Second, we examined if race affected whether veterans who met criteria for a SCID PTSD diagnosis were classified as having PTSD by their C&P examiner (i.e., true positive) or not (i.e., false negative). If race does not affect concordance, we would expect rates at which veterans with a SCID PTSD diagnosis to be classified as true positives versus false negatives to be equivalent for White and Black veterans. Third, we examined if race affected whether veterans who did not meet criteria for a SCID PTSD diagnosis were classified as having PTSD by their C&P examiner (i.e., false positive) or not (i.e., true negative). If race does not affect concordance, we would expect rates at which veterans without a SCID PTSD diagnosis to be classified as true negatives versus false positives to be equivalent for White and Black veterans. For each of these questions, we conducted logistic regressions to see if race affected these different aspects of concordance after controlling for demographic variables that could potentially influence PTSD status (i.e., age, gender, education and income), as well as combat exposure, as assessed by the DRRI, and the amount of time between the Project VALOR assessment and the PTSD disability exam.

Finally, we examined whether the use of psychometric testing during a PTSD disability exam affected concordance between the C&P exam and the SCID. To do so, we first split the sample by whether psychometric testing was used during the disability exam. For each group, we then reran the logistic regressions examining the effect of race on overall concordance, categorization of SCID PTSD positive participants into true positive versus false negative, and categorization of SCID PTSD negative participants into true negative versus false positive. If psychometric testing had no effect, we would expect the outcomes of two sets of analyses to match each other as well as those for the full sample.

Because the PTSD disability examination is only one (albeit important) aspect of determining SC status, we were also interested in how the C&P examiner diagnosis related to SC status among participants in our sample. Therefore, we conducted a Pearson correlation to determine the association between C&P examiner PTSD diagnosis and SC status. Further, we were interested in examining whether our findings regarding race for C&P examiner PTSD also held for SC status. Therefore, we classified participants into true positives, true negatives, false positives, and false negatives based on SCID PTSD status and SC status (rather than C&P examiner PTSD diagnosis), and reran the three logistic regressions described previously.

Results

Diagnostic Concordance Between C&P Examiner PTSD Diagnosis and SCID PTSD Diagnosis

Concordance between both current and lifetime SCID PTSD diagnosis and C&P examiner PTSD diagnosis is reported in Table 1. The overall concordance rate was 70.4% for current PTSD and 77.7% for lifetime PTSD. Individuals who received a PTSD diagnosis from their C&P examiners were more than three times as likely as those who did not to also receive a current SCID PTSD diagnosis (odds ratio [OR] = 3.39, 95% confidence interval [CI] = 2.25–5.15, $p < .001$). The most frequent outcome using current SCID PTSD was true positive (62.9%) and the least frequent outcome was true negative (7.4%). There were slightly more false positives than false negatives (16.4% vs. 13.1%).

Race and Diagnostic Concordance

The average number of PTSD symptoms reported during the current SCID interview did not significantly differ between White ($M = 11.45$, $SD = 3.59$) and Black veterans ($M = 11.76$, $SD = 3.43$); $t(747) = -.87$, $p = .39$. Logistic analyses revealed that race did not significantly affect the overall concordance between current SCID PTSD diagnosis and C&P examiner PTSD diagnosis (74.8% concordance for White veterans vs. 74.4% concordance for Black veterans; $OR = .97$, $p = .90$; CI = .60–1.57; see Table 2). However, race did significantly affect several important aspects of concordance. Specifically, compared with Black veterans who did not receive a current PTSD diagnosis on the SCID, the odds were four times as great that White veterans who did not receive a current PTSD diagnosis on the SCID would receive a PTSD diagnosis from their C&P examiner (i.e., White veterans were more likely to be false positives than Black veterans; 26.5% vs. 54.5%, respectively; $OR = 4.07$, $p < .001$; CI = 1.51–10.92; see Table 2).

Among veterans who received a current SCID PTSD diagnosis, Black veterans were again less likely to receive a PTSD diagnosis from the C&P examiner than White veterans (78.9% vs. 90.8%, respectively). Specifically, Black veterans who received a current

Table 1

Contingency Tables for C&P Examiner PTSD Diagnosis and SCID PTSD Diagnosis

	C&P PTSD diagnosis	
Diagnosis	No	Yes
Current SCID PTSD diagnosis		
No	57 (7.4%)[a]	100 (13.1%)[b]
Yes	126 (16.4%)[c]	481 (62.9%)[d]
Lifetime SCID PTSD diagnosis		
No	31 (4.1%)[a]	125 (16.4%)[b]
Yes	45 (5.9%)[c]	560 (73.5%)[d]

Note. C&P = compensation and pension; SCID = Structured Clinical Interview for DSM-IV; PTSD = posttraumatic stress disorder; [a] TN = true negatives; [b] FP = false positives; [c] FN = false negatives; [d] TP = true positives. Overall concordance for C&P Diagnosis and Current SCID Diagnosis (TP + TN) = 70.4% ($n = 538$). Overall concordance for C&P Diagnosis and Lifetime SCID Diagnosis (TP + TN) = 77.7% ($n = 591$).

Table 2

Race as a Predictor of Concordance Between Current SCID PTSD Status and C&P PTSD Status

Variable	Concordance vs. discordance		False positive vs. true negative		False negative vs. true positive	
	OR	CI	*OR*	CI	*OR*	CI
White vs. Black	.97	.60–1.57	4.07**	1.51–10.92	.39**	.20–.73
Combat exposure	.97**	.96–.99	.98	.94–1.01	1.04**	1.02–1.07
Education	1.02	.90–1.16	1.05	.82–1.36	1.01	.83–1.23
Gender	1.30	.89–1.92	1.47	.67–3.25	.65	.35–1.22
Income	.94	.83–1.06	.98	.76–1.27	1.06	.88–1.29
Age	.99	.97–1.01	1.01	.97–1.04	1.01	.98–1.04
Months between Project VALOR assessment and C&P examination	1.01	1.00–1.02	1.02*	1.00–1.04	.99	.98–1.01

Note. C&P = compensation and pension; *OR* = odds ratio; CI = confidence interval; VALOR = Veterans After-Discharge Longitudinal Registry.
* $p < .05$. ** $p < .01$.

SCID PTSD diagnosis had less than half the odds of White veterans of receiving a PTSD diagnosis from their C&P examiners (i.e., Black veterans were more likely to be false negatives than White veterans; *OR* = .39, $p < .001$, CI = .20–.73, see Table 2).

When we reran these analyses using lifetime SCID PTSD diagnostic status, overall concordance was significantly different as a product of race, such that White veterans had higher rates of concordance than Black veterans (84.1% vs. 74.4%; *OR* = 1.70, $p = .04$, CI = 1.03–2.81). This effect was due likely to the fact that although White veterans were still more likely to be false positives than Black veterans, this effect was no longer significant (61.5% vs. 40.0%; *OR* = 3.32, $p = .14$, CI = .68–16.26). Consistent with our findings for current SCID PTSD, when examining lifetime SCID PTSD, Black veterans were again significantly more likely to be false negatives than White veterans (24.3% vs. 10.6%; *OR* = .37, $p < .001$, CI = .21–.65).

Psychometric Testing, Race, and Diagnostic Concordance

Most disability exams (75.8% of exams overall; 80.3% of exams for Black veterans; 75.0% of exams for White veterans) did not include any psychometric testing. Of those that did, the most commonly used instruments, in order, were the PTSD Checklist (Weathers, Litz, Herman, Huska, & Keane, 1993; 15.4%), the

Minnesota Multiphasic Personality Inventory (Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989; 11.8%), the Mississippi Scale for Combat-Related PTSD (Keane, Caddell, & Taylor, 1988; 10.6%), the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961; 9.4%), and the Clinician-Administered PTSD Scale (Blake et al., 1995; 7.1%).

To examine whether the use of testing during PTSD disability exams moderated the association between race and diagnostic concordance, the sample was split based on whether psychometric testing was used during the disability exam conducted most proximally to the Project VALOR SCID interview. In the subgroup of veterans that was administered a psychometric test during their disability exam, race did not significantly affect the overall concordance between current SCID PTSD diagnosis and C&P examiner PTSD diagnosis (*OR* = .92, $p = .88$; CI = .32–2.66; see Table 3). Interestingly, in this subgroup, White veterans were no more likely than Black veterans to be false positives (63.9% vs. 75.0%, respectively; *OR* = .43, $p = .56$, CI = .03–7.28), and Black veterans were no more likely than White veterans to be false negatives (15.8% vs. 15.5%; *OR* = 1.45, $p = .62$, CI = .34–6.24, see Table 3). In the subgroup that was not administered a psychometric test during their disability exam, overall concordance was again not significantly affected by race (*OR* = .89, $p = .69$; CI =

Table 3

Race as a Predictor of Concordance Between Current SCID PTSD Status and C&P PTSD Status for Cases in Which Psychometric Testing was Used

Variable	Concordance vs. discordance		False positive vs. true negative		False negative vs. true positive	
	OR	CI	*OR*	CI	*OR*	CI
White vs. Black	.92	.32–2.66	.43	.03–7.28	1.45	.34–6.24
Combat exposure	.97	.94–1.01	.89*	.80–1.00	1.05	1.00–1.10
Education	.85	.64–1.12	1.73	.89–3.35	1.17	.77–1.78
Gender	1.38	.63–3.06	5.12	.67–39.30	.48	.15–1.60
Income	1.04	.81–1.35	.74	.43–1.27	1.28	.86–1.91
Age	1.00	.96–1.04	.97	.89–1.06	1.00	.92–1.04
Months between Project VALOR assessment and C&P examination	1.00	.98–1.02	1.02	.97–1.07	1.01	.98–1.04

Note. C&P = compensation and pension; *OR* = odds ratio; CI = confidence interval; VALOR = Veterans After-Discharge Longitudinal Registry.
* $p < .05$.

.52–1.56; see Table 4). However, unlike the subgroup that was administered a psychometric test during their disability exam, for this group, the previously described relationships remained significant. Specifically, White veterans were significantly more likely to be false positives than Black veterans (76.1% vs. 38.9%; *OR* = 7.00, *p* < .001, CI = 2.21–22.14), and Black veterans were significantly more likely to be false negatives than White veterans (21.3% vs. 7.2%; *OR* = .29, *p* < .001, CI = .14-.61; see Table 4).

Results of analyses with lifetime SCID PTSD diagnosis followed the same general pattern of results. For the subgroup that did not receive psychometric testing, White veterans demonstrated significantly more overall concordance than Black veterans (85.5% vs. 73.1%; *OR* = 1.80, *p* = .04, CI = 1.02–3.17). In addition, more White veterans (64.0%) than Black veterans (37.5%) were false positives and this effect was marginally significant (*OR* = 8.35, *p* = .06, CI = .92–75.71). Similar to both the overall lifetime SCID PTSD findings and the findings for current SCID PTSD, Black veterans were significantly more likely to be false negatives than White veterans (25.9% vs. 8.5%; *OR* = .28, *p* < .001, CI = .15–.53). However, for the subgroup that received psychometric testing, these effects disappeared. There was no longer a significant effect of race on overall concordance (79.3% of White veterans vs. 82.6% of Black veterans; *OR* = .94, *p* = .93, CI = .28–3.25), rate of false positives (50% of White veterans vs. 50% of Black veterans; *OR* = 3.16, *p* = .67, CI = .02–656.64), or rate of false negatives (14.3% of White veterans vs. 17.6% of Black veterans; *OR* = 1.40, *p* = .64, CI = .35–5.62).

SC Status

As expected, a Pearson correlation revealed a significant positive relationship between C&P PTSD status and the respondent's SC status, *r* = .73, *p* < .001. Among respondents who were diagnosed with PTSD during their C&P exam, 91.9% were service connected for PTSD. Among respondents who were denied a PTSD diagnosis during the C&P exam, 86.6% were not service connected for PTSD. Further, when we examined the association between race and concordance between SCID PTSD status and SC status, the pattern of results was identical to those of race and concordance between SCID PTSD status and C&P PTSD status. Specifically, similar to the results reported earlier, there was no

significant relation between race and overall concordance (*OR* = .90, *p* = .65, CI = .57–1.43). However, race did significantly affect several important aspects of concordance, such that White veterans who did not meet SCID PTSD criteria were less likely than Black veterans who did not meet SCID PTSD criteria to be denied PTSD service connection (26.9% vs. 60.9%, respectively; *OR* = 4.50, *p* < .001, CI = 1.71–11.82), and Black veterans who met PTSD SCID criteria were less likely to receive PTSD service connection compared with White veterans who met PTSD SCID criteria (74.0% vs. 84.5%, respectively; *OR* = .54, *p* = .03, CI = .31-.94; see Table 5).

Results of the analyses examining concordance between SC status and lifetime SCID PTSD diagnostic status demonstrated a pattern of results nearly identical to those for C&P examiner PTSD diagnostic status and lifetime SCID PTSD diagnostic status. Specifically, overall concordance was again significantly different by race, such that White veterans demonstrated significantly higher levels of overall concordance than Black veterans (79.3% vs. 68.9%; *OR* = 1.61, *p* = .04, CI = 1.01–2.57). Although nonsignificant, White veterans had higher rates of false positives than Black veterans (62.1% vs. 40%; *OR* = 3.34, *p* = .13, CI = .69–16.13). Further, Black veterans were significantly more likely to be false negatives than White veterans (30.3% vs. 16.0%; *OR* = .45, *p* < .001, CI = .27–.75).

Discussion

We found that C&P PTSD diagnoses were concordant with current SCID PTSD status in 70.4% of cases and with lifetime SCID PTSD status in 77.7% of cases. These finding builds upon previous work by Marx et al. (2016), which demonstrated a similar concordance rate between SCID PTSD status and SC status using the same dataset. Although these results suggest that, in most cases, PTSD diagnoses rendered by C&P examiners are likely accurate, the number of false positives and false negatives does support prior concerns that PTSD disability exam outcomes may be incorrect for a significant minority of veterans. Our findings support concerns raised by others about the possible failings of the VA PTSD disability examination process (e.g., Frueh, Grubaugh, Elhai, & Buckley, 2007; Jackson et al., 2011; McNally & Frueh, 2013; OIG, 2005; Speroff et al., 2012; Worthen & Moering, 2011)

Table 4

Race as a Predictor of Concordance Between Current SCID PTSD Status and C&P PTSD Status for Cases in Which Psychometric Testing Was Not Used

Variable	Concordance vs. discordance		False positive vs. true negative		False negative vs. true positive	
	OR	CI	*OR*	CI	*OR*	CI
White vs. Black	.89	.52–1.56	7.00**	2.21–22.14	.29**	.14–.61
Combat exposure	.98**	.96–.99	.99	.95–1.02	1.05**	1.01–1.08
Education	1.08	.94–1.25	.88	.65–1.19	.99	.78–1.25
Gender	1.17	.75–1.85	1.01	.40–2.65	.74	.34–1.61
Income	.89	.77–1.03	1.10	.80–1.51	1.04	.82–1.32
Age	.99	.97–1.02	1.01	.97–1.05	1.01	.97–1.05
Months between Project VALOR assessment and C&P examination	1.01	1.00–1.02	1.02	1.00–1.04	.99	.97–1.00

Note. C&P = compensation and pension; *OR* = odds ratio; CI = confidence interval; VALOR = Veterans After-Discharge Longitudinal Registry.
** *p* < .01.

Table 5

Race as a Predictor of Concordance Between Current SCID PTSD Status and SC Status

Variable	Concordance vs. discordance		False positive vs. true negative		False negative vs. true positive	
	OR	CI	OR	CI	OR	CI
White vs. Black	.90	.57–1.43	4.50**	1.71–11.82	.54*	.31–.94
Combat exposure	.97**	.95–.98	.98	.95–1.01	1.05**	1.03–1.08
Education	1.10	.97–1.23	.92	.72–1.18	.91	.77–1.08
Gender	1.32	.92–1.90	1.05	.50–2.22	.72	.43–1.21
Income	.98	.88–1.10	.84	.65–1.08	1.06	.91–1.25
Age	.99	.98–1.01	1.00	.97–1.03	1.01	.99–1.04
Months between Project VALOR assessment and C&P examination	1.01	1.00–1.01	1.01	1.00–1.03	.99	.98–1.01

Note. C&P = compensation and pension; *OR* = odds ratio; CI = confidence interval; VALOR = Veterans After-Discharge Longitudinal Registry.
** *p* < .01.

and indicate that we should be concerned about both the number of veterans who may have PTSD who are not given the diagnosis by a C&P examiner (and are, therefore, also most likely denied the associated benefits including recognition that their disorder is military service related, access to free health care, and potential monetary compensation) and the number of veterans who are diagnosed with PTSD by a C&P examiner and receiving associated benefits when they may not be entitled to do so. Although questions and concerns about the latter have been discussed at great length, much less attention has been paid to the former even though research has shown that veterans receiving PTSD disability benefits report greater reductions in PTSD symptoms as well as less poverty and less homelessness than those who are denied these benefits (Murdoch et al., 2011).

Importantly, our study cannot provide a definitive explanation for discrepancies between C&P examiner PTSD diagnoses and SCID PTSD diagnoses. Possible explanations include insufficient knowledge or inadequate disability examination practices among C&P examiners, patient or institutional pressures, atypical symptom presentation, examiner biases, and inaccurate symptom reporting by veterans during either the disability exam or the SCID interview. In addition, because in many cases the SCID assessment occurred many months after the disability exam, it is entirely possible that some discrepancies may be the result of natural symptom fluctuations over time and remission or reduction of symptoms as function of treatment or other factors (though time from the disability exam to the SCID assessment was controlled for in our analyses and we also used the lifetime SCID PTSD diagnosis in subsequent analyses and those results generally supported those using the current SCID PTSD diagnosis).

Perhaps even more concerning than the discovery of these diagnostic discrepancies per se is the finding that, among veterans diagnosed with PTSD by an independent evaluator, Black veterans were significantly less likely than White veterans to receive both a C&P PTSD diagnosis and to be given PTSD service connection status. Further, among veterans not meeting diagnostic criteria for SCID PTSD, Black veterans tended to be more likely than White veterans to be denied both C&P PTSD status and PTSD service connection status. These results are consistent with our hypotheses as well as with findings from other studies that have documented racial disparities in VA care (Rosenheck et al., 1995), the amount of compensation given for service connected PTSD (Murdoch et

al., 2003), and satisfaction with VA PTSD disability exams (Rosen et al., 2013).

Although our results provide evidence of racial disparities in the PTSD disability exam and PTSD service connection rating process, the source of such disparities remains unclear. One possibility could be implicit racial biases (i.e., beliefs that occur without conscious awareness which are frequently contrary to an individual's explicit beliefs; Devine, 1989) among C&P examiners. Research has demonstrated that the existence of implicit bias from the automatic activation of race and other stereotypes can influence judgment of, and behavior toward, individuals from a stereotyped group (Devine & Plant, 2012). Medical professionals, who work under conditions of uncertainty and time pressure, may be more likely to rely on stereotypes in decision-making (Chapman, Kaatz, & Carnes, 2013); this may make them vulnerable to their implicit bias. Indeed, a number of studies have documented the presence of implicit racial biases among medical professionals, despite the absence of explicit bias (Cooper et al., 2012; Green et al., 2007; Sabin & Greenwald, 2012; Sabin, Nosek, Greenwald, & Rivara, 2009). Further, research has suggested that these implicit racial biases can result in health care disparities (Chapman et al., 2013; Cooper et al., 2012).

Implicit biases, in turn, may influence how Black patients perceive their providers and interactions with them. Specifically, research indicates that stereotype threat (i.e., a situation in which one is "at risk of confirming, as self-characteristic, a negative stereotype about one's group;" Steele & Aronson, 1995, p. 797), may occur in health care environments. As such, if Black patients perceive cues that suggest implicit biases in their providers, these cues may threaten clinical interactions and patient adherence (Aronson, Burgess, Phelan, & Juarez, 2013). For instance, Black patients tend to perceive physicians with greater implicit racial bias, even when they have positive explicit racial attitudes, as less warm and friendly (Penner et al., 2013) and have less trust and confidence in them (Blair et al., 2013; Cooper et al., 2012). Importantly, patients with these perceptions may be less likely to cooperate with their doctors (Penner et al., 2013) or follow through on their recommendations (e.g., Bogart, Wagner, Galvan, & Banks, 2010; Dovidio et al., 2008). In the context of a VA PTSD disability examination, these interpersonal dynamics are important to be mindful of, as veterans who are suspicious, uncooperative, and/or unwilling to answer certain questions about their legal

histories or other sensitive topics may be perceived by their examiners as devious or dishonest about their reported PTSD symptoms and their association with military service for secondary gain purposes.

Health care systems and institutional factors may also contribute to disparities; for instance, studies have found that Black and White patients tend to seek care in different settings (because of factors such as geography and socioeconomic status), and that Black patients are more likely to receive care in settings with fewer resources or in which providers are not as well trained (Bach, Pham, Schrag, Tate, & Hargraves, 2004). These sources are especially important to consider in light of the OIG investigation (OIG, 2005), which indicated that the state where disability exams are given influenced results. Previous research shows that the average rate of PTSD SC granted varies widely by region (Murdoch, Hodges, Cowper, & Sayer, 2005); therefore, it is also possible that the racial differences found in this study are consequences of regional differences in the C&P disability exam process. The relatively small proportion of Black participants in our sample prevented us from conducting follow-up analyses on the impact of geographic region on racial disparities found in concordance rates. Future research should study the provider, institution, and regional level characteristics that may contribute to the diagnostic accuracy of C&P examinations for PTSD.

We also found that the use of psychometric testing during a disability exam influenced the association between race and diagnostic concordance. For the disability exams in which psychometric testing was not used, discrepancies continued to emerge which favored White veterans over Black veterans. In contrast, in the disability exams in which psychometric testing was used, there was no significant relationship between race and diagnostic concordance. These findings were consistent with our hypothesis that, especially in the absence of psychometric testing, there is a discrepancy in PTSD-related outcomes between Black and White veterans in the VA disability process.

Our findings suggest that more widespread use of psychometric testing in VA PTSD disability exams may help to reduce the racial differences found in both C&P examiner and SC concordance. It may be that the use of psychometric measures of PTSD reduces the possibility that the examiner will be influenced by factors other than those pertinent to the diagnostic process (e.g., implicit racial bias). Consistent with this possibility, research has suggested that the effect of implicit bias can be reduced through individuating (i.e., applying conscious effort to focus on specific information about an individual; Chapman et al., 2013). One method for individuating is providing specific diagnostic information about an individual patient (e.g., test results); this practice has been shown to reduce implicit bias in diagnostic decisions specifically (Chapman, Tashkin, & Pye, 2001). The standardized use of empirically supported psychometric tests in VA PTSD disability exams is also consistent with prior recommendations to reduce health disparities by improving the quality of medical care (McGuire & Miranda, 2008). Unfortunately, the use of such tests in VA PTSD disability exams is the exception, not the rule. We found that only 24.2% of C&P exams used a psychometric test of some form, consistent with previous survey results in which the majority of C&P examiners reported "rarely" or "never" using testing (Jackson et al., 2011).

The findings of racial differences in concordance are particularly important to address due to the high correlation between the outcome of the disability exam and SC status. This suggests that a failure to use psychometric tests in PTSD disability exams may be directly responsible for fewer Black veterans receiving the disability benefits owed to them, and a greater number of White veterans without PTSD erroneously receiving benefits. Given that SC status has been associated with reduced rates of impoverishment (Murdoch et al., 2005) and homelessness (Edens, Kasprow, Tsai, & Rosenheck, 2011), such a pattern is highly detrimental to Black veterans and their families.

There are several limitations to this study. First, the current sample is not representative of all VA patients. Only veterans of OEF/OIF/OND were included in the present analyses, all participants had previously undergone a mental health assessment at a VA facility, and veterans with probable PTSD were oversampled at a ratio of 3:1. In addition, it is possible that the relationship between race and diagnostic concordance found here is better explained by a third variable that was not examined, such as the region in which the exam was conducted. Furthermore, because respondents were not randomly assigned to the psychometric testing group, it is possible that the psychometric testing variable is actually capturing some other feature of the exam process, such as the training of the C&P examiner, the number of evaluations a veteran has completed, or the amount of time allowed for an examination. Future research is needed to explore these possibilities.

Our results indicate that racial disparities may account for the 30% discordance observed between the VA PTSD disability exam diagnosis and an independently administered semistructured PTSD diagnostic interview. Psychometric testing during PTSD disability exams shows promise as a means of reducing these racial differences. Future research should continue to examine the impact of psychometric testing on the VA PTSD disability process. Because the C&P exam results are a key component in determining whether a veteran receives PTSD SC, findings of racial disparities in concordance involving C&P exams may also translate into racial differences in rates of PTSD SC. Such a disparity would have important financial implications for veterans seeking disability benefits through the C&P exam process. Therefore, implementation of psychometric testing and other clinical practices that can improve the validity of disability exam outcomes and eliminate racial differences in the VA disability exam process is necessary.

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Network Models of *DSM–5* Posttraumatic Stress Disorder: Implications for *ICD–11*

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Recent proposals for revisions to the 11th edition of the *International Classification of Diseases* (*ICD–11*) posttraumatic stress disorder (PTSD) diagnostic criteria have argued that the current symptom constellation under the *Diagnostic and Statistical Manual of Mental Disorders-5* is unwieldy and includes many symptoms that overlap with other disorders. The newly proposed criteria for the *ICD–11* include only 6 symptoms. However, restricting the symptoms to those included in the *ICD–11* has implications for PTSD diagnosis prevalence estimates, and it remains unclear whether these 6 symptoms are most strongly associated with a diagnosis of PTSD. Network analytic methods, which assume that psychiatric disorders are networks of interrelated symptoms, provide information regarding which symptoms are most central to a network. We estimated network models of PTSD in a national sample of veterans of the Iraq and Afghanistan wars. In the full sample, the most central symptoms were persistent negative emotional state, efforts to avoid external reminders, efforts to avoid thoughts or memories, inability to experience positive emotions, distressing dreams, and intrusive distressing thoughts or memories; that is, 3 of the 6 most central items to the network would be eliminated from the diagnosis under the current proposal for *ICD–11*. An empirically defined index summarizing the most central symptoms in the network performed comparably to an index reflecting the proposed *ICD–11* PTSD criteria at identifying individuals with an independently assessed *DSM–5* defined PTSD diagnosis. Our results highlight the symptoms most central to PTSD in this sample, which may inform future diagnostic systems and treatment.

General Scientific Summary
This study suggests that persistent negative emotional state, efforts to avoid external reminders, efforts to avoid thoughts or memories, inability to experience positive emotions, distressing dreams, and intrusive distressing thoughts or memories are important to the PTSD network. Findings were similar for men and women.

Keywords: posttraumatic stress disorder, network analysis, *ICD–11*

Supplemental materials: http://dx.doi.org/10.1037/abn0000252.supp

The *Diagnostic and Statistical Manual of Mental Disorders* (*DSM*) criteria for posttraumatic stress disorder (PTSD) have received criticism for including symptoms that overlap with many other mental disorders (e.g., anxiety disorders, mood disorders, dissociative disorders; Brewin, Lanius, Novac, Schnyder, & Galea, 2009; Rosen & Lilienfeld, 2008; Rosen, Spitzer, & McHugh, 2008). For example, PTSD and major depressive disorder (MDD) share several diagnostic criteria: sleep disturbance, difficulty concentrating, and anhedonia (American Psychiatric Association, 2013). Concerns about the extent to which the symptoms of PTSD overlap with symptoms of other mental disorders were renewed following publication of the fifth edition of the *DSM* (e.g., Brewin, 2013). In the fifth revision of the *DSM* (*DSM–5*), the number of PTSD symptoms was expanded from 17 to 20, and those that were added (i.e., distorted blaming of oneself or others, persistent negative emotional state, and self-destructive or reckless behavior) overlap with symptoms of other mental disorders. Critics have suggested that such syndromal indistinctiveness may not only inflate the estimated worldwide prevalence of PTSD but possibly undermine the validity of the PTSD diagnosis (Rosen, Lilienfeld, Frueh, McHugh, & Spitzer, 2010; Spitzer, Rosen, & Lilienfeld, 2008).

To address this persistent concern, some have suggested that these overlapping symptoms be eliminated from the PTSD diagnosis (e.g., Spitzer, First, & Wakefield, 2007). In contrast to the *DSM–5*'s 20 PTSD symptoms, the newly proposed PTSD criteria for the 11th edition of the *International Classification of Diseases* (*ICD–11*) include only six symptoms. In reducing the number of PTSD symptoms, the stated goals of the *ICD–11* PTSD working group are to improve diagnostic utility (i.e., sensitivity and specificity) and decrease psychiatric comorbidity (Maercker et al., 2013). The six symptoms chosen by the *ICD–11* working group (distressing dreams, dissociative reactions (flashbacks), efforts to avoid thoughts or memories, efforts to avoid external reminders, hypervigilance, and exaggerated startle response) were assumed to be both core to the entity of PTSD and not shared by other psychiatric disorders (Cloitre, Garvert, Brewin, Bryant, & Maercker, 2013; Maercker et al., 2013). At least one reexperiencing symptom (distressing dreams or dissociative flashbacks), one avoidance symptom (efforts to avoid thoughts or memories or efforts to avoid external reminders), and one hyperarousal symptom (hypervigilance or exaggerated startle response), plus distress or impairment, is to be required for an *ICD–11* PTSD diagnosis.

Recent empirical studies have found that restricting the symptoms to those included in the *ICD–11* has important implications for the estimated prevalence of PTSD. For example, Hansen, Hyland, Armour, Shevlin, and Elklit (2015) found that 30.4% of participants with varying trauma exposure histories received *DSM–5* PTSD diagnoses, but only 22.6% received *ICD–11* diagnoses. Recently, Wisco and colleagues (2016) found past-month prevalence estimates of 3.7% for *DSM–5* PTSD and 2.4% for *ICD–11* PTSD in a U.S. community-based sample and 38.7% (*DSM–5*) and 34.4% (*ICD–11*) in a sample of trauma-exposed veterans. Across these samples and a third sample of US veterans and their intimate partners, 20.8–54.7% of participants meeting *DSM–5* criteria for PTSD did not meet *ICD–11* criteria; the main reasons for this discrepancy were lack of endorsement of distressing dreams or dissociative flashbacks and lack of endorsement of hypervigilance or exaggerated startle response despite endorsing other intrusion and alterations in arousal and reactivity symptoms that were sufficient for meeting the *DSM–5* PTSD criteria (Wisco et al., 2016).

Although many PTSD symptoms overlap with symptoms of other mental disorders, many disorders, particularly mood and anxiety disorders, share symptoms (Byllesby, Charak, Durham, Wang, & Elhai, 2016; Watson, 2005; Zbozinek et al., 2012). Further, there are several important questions that need to be addressed before we can presume that the nonspecific symptoms can or should be eliminated. First, we do not know if any nonspecific symptoms are essential for a diagnosis of PTSD, that is, the extent to which they have strong predictive value for diagnostic caseness. Second, we do not know which PTSD-specific symptoms are most central to the PTSD diagnosis, such that, by having strong connections with many other symptoms, the most central variables provide the most information about the other symptoms in the model. It remains unclear if the six symptoms chosen for inclusion in the *ICD–11* are the most appropriate to reduce comorbidity with other diagnoses and to retain the most central features of the diagnosis; in other words, these six symptoms may not be the most essential symptoms of PTSD, nor are they necessarily more impairing than other PTSD symptoms that were not selected for inclusion under *ICD–11*. Although factor analytic studies of the *ICD–11* PTSD criteria have generally found that this model fits the data well across samples (Hansen et al., 2015), these studies are unable to tell us if the symptoms chosen for inclusion in *ICD–11* are those that best represent the diagnosis as currently defined.

Network analytic methods, previously used to examine connections between individuals and disease symptoms as well as actors associated via "degrees of separation" with Kevin Bacon (Barabási, 2003; Barabási & Oltvai, 2004; Brandes & Erlebach, 2005), were recently applied to the study of psychiatric symptoms and may help answer the question of which symptoms are the foundation of the PTSD diagnosis. Network models provide a visual representation of associations among variables and focus on direct associations among symptoms, an approach that aligns well with the theory that PTSD symptoms have direct causal effects on one another. For example, alterations in arousal and reactivity symptoms have been associated with emotional numbing (diminished interest in activities, detachment from others, inability to experience positive emotions; Litz et al., 1997). Also, it has been hypothesized that avoidance symptoms may develop because of intrusion symptoms (Creamer, Burgess, & Pattison, 1992). Thus, network models are a natural fit for the study of interrelationships among PTSD symptoms.

Network model results also provide information about which variables are most central to a given network. The only published network analysis of *DSM–IV* PTSD symptoms was conducted using a sample of 362 trauma-exposed Chinese adults, and findings revealed that difficulty concentrating, sleep disturbance, hypervigilance, and distressing dreams were highly central to the network (McNally et al., 2015). Importantly, only two of the proposed *ICD–11* PTSD criteria (nightmares and hypervigilance) were identified as being most central to the network in this sample.

Item centrality results could be useful in determining which symptoms are most essential to a diagnosis of PTSD. Individuals with higher scores on the most central items should have higher overall PTSD severity scores and a greater likelihood of receiving

a diagnosis of PTSD compared with individuals with lower scores. For example, in a study of complicated grief, change in the activation of highly central symptoms over time, relative to less central symptoms, was more strongly associated with naturalistic change in activation of the overall network (Robinaugh, Millner, & McNally, 2016). Symptoms with high centrality scores may be important targets for treatment, as addressing these symptoms would, in theory, affect the larger network and also inform which symptoms provide the most information about other symptoms in the network (van Borkulo et al., 2015). However, this proposition has not yet been tested.

Network model results may also be useful for examining comorbidity among psychiatric disorders. Symptoms shared by disorders may appear in the graphs as *bridge* symptoms, linking the two disorders (Borsboom & Cramer, 2013; Cramer, Waldorp, van der Maas, & Borsboom, 2010). Further, evaluating the extent to which the most central PTSD symptoms are also related to comorbid diagnoses (e.g., MDD) would partly address concerns regarding syndromal indistinctiveness. These findings could have important implications for the *ICD–11* definition of PTSD, which purports to restrict PTSD symptoms to those not shared by other disorders.

An additional important point to address is the extent to which there are sex differences in models of PTSD or patterns of PTSD symptom endorsement. The lifetime prevalence of PTSD in the general U.S. adult population is more than twice as high among women (11.7%) as men (4.0%; Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012), as is the 12-month prevalence (5.2% women, 1.8% men; Kessler, Chiu, Demler, Merikangas, & Walters, 2005; Kessler, Chiu, Demler, & Walters, 2005). It is noteworthy, however, that sex differences in prevalence may depend on trauma type and are less apparent in highly trauma-exposed samples (Street, Vogt, & Dutra, 2009; Wolf et al., 2013). For example, Street, Gradus, Giasson, Vogt, and Resick (2013) found comparable rates of probable past-month PTSD among male (23.4%) and female (21.0%) veterans of the Iraq and Afghanistan wars, indicating that trauma severity may equalize rates of PTSD among men and women. However, a recent prospective study found that the effect of combat experiences on postdeployment PTSD was stronger for women than men (Polusny et al., 2014). In addition, it has been suggested that the factor structure of PTSD may differ for women compared with men. Specifically, a previous study of adolescents found significantly higher error variances among female participants relative to male participants, suggesting that the latent PTSD factors did not account for as much of the item covariance among girls (Armour et al., 2011). These findings offer compelling reasons to assess for sex similarities and differences in PTSD studies, as failing to address potential sex differences in symptoms may have the unintended consequence of biasing the diagnostic criteria toward one sex or the other. In many studies of PTSD among veterans, it is nearly impossible to evaluate sex differences in the phenomenology of the disorder because of the traditionally smaller number of female veterans. This study addresses this limitation.

In this study, we used network models to examine the centrality of each of the PTSD symptoms included in the *DSM–5*. In doing so, our objectives were: 1a) to evaluate the proposed *ICD–11* revisions to the PTSD criteria by examining the centrality of the six symptoms suggested for inclusion; 1b) to the extent that these six symptoms are not the most central, to further examine network model results to determine which PTSD symptoms are the most central; 2) to determine the extent to which the *ICD–11* versus the most central symptoms in the network could be used to index independently assessed *DSM–5* PTSD diagnoses; 3a) to evaluate a network model of PTSD and MDD symptoms to better understand how symptoms of each disorder are related to one another; 3b) to investigate the extent to which the *ICD–11* and most central symptoms were associated with MDD; and 4) to compare results across men and women using a sample in which there were equal numbers of female and male veterans.

Method

Participants

Participants in this study were Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) veterans enrolled in the Veterans After-discharge Longitudinal Registry (Project VALOR), a longitudinal national registry of Iraq and Afghanistan Army and Marine Corps veterans (Rosen et al., 2012). To be included in Project VALOR, veterans must have undergone a mental health evaluation at a VA facility. Veterans with probable PTSD (i.e., at least two instances of a PTSD diagnosis by a mental health professional associated with two separate visits) according to VA medical records were oversampled to create a 3:1 (PTSD: no PTSD) ratio, and women, underrepresented among veterans, were oversampled to create a 1:1 sex ratio. The VA Environmental Epidemiology Service provided a roster of veterans who met inclusion criteria. Potential participants received opt-out letters; those who did not return the letter, thus providing tacit agreement for future contact, were telephoned by study staff who provided additional information and assessed whether they were also currently participating in a clinical trial (an exclusion criterion). The data from 1,649 male and female veterans who completed both questionnaires and a diagnostic interview were included in Project VALOR. Further details on study design and recruitment are available in previous publications (Rosen et al., 2012).

For the purposes of this study, we employed a subsample of 1,458 Project VALOR veterans who completed the PTSD Checklist for *DSM–5* (PCL-5; Weathers et al., 2013). Their average age was 40.69 (*SD* = 9.79); 51.1% were female. The majority (73.6%) were White, 15.9% were Black, 3.3% were American Indian or Alaska Native, 2.1% were Asian, 0.6% were Pacific Islander, 1.4%, reported other races, and 11.7% were Hispanic. Data for the current study were collected during Phase 2 of Project VALOR, the first-time point that included *DSM–5* PTSD assessments.

Measures

Demographics. Participants completed a demographic questionnaire online or by mail. They reported their age, race, and sex.

Life Events Checklist for *DSM–5* (LEC-5). The LEC-5 (Gray, Litz, Hsu, & Lombardo, 2004; Weathers et al., 2013), is a two-part self-report questionnaire of trauma exposure. In part one, participants are asked to indicate if they experienced, witnessed, learned about, or were repeatedly exposed to any of 16 potentially traumatic events, or another extraordinarily stressful event not captured by the first 16 items. In part two, participants are asked to

identify the worst event of those they endorsed, and provide additional information about the event.

Structured Clinical Interview for *DSM–5* (SCID-5). The SCID-5 (First, Williams, Karg, & Spitzer, 2015) was used to assess current (past month) PTSD diagnostic status. The SCID-5 for PTSD has good reliability (κ = .69; Regier et al., 2013). We also employed the SCID-5 MDD module to assess current MDD diagnostic status. A previous study found that SCID-5 for MDD had poor reliability (κ = .20-.35; Clarke et al., 2013). However, in the present study, interrater agreement was excellent for both PTSD (κ = .82) and MDD (κ = .75) among a random subset of interviews (*n* = 100) that were independently reviewed and rated by an assessor who did not complete the initial interview.

PTSD Checklist for *DSM–5* (PCL-5). The PCL-5 (Weathers et al., 2013) is a 20-item self-report measure that assesses *DSM–5* symptoms of PTSD and was the focus of the network model analyses. For each symptom, respondents provide a severity rating ranging from 0 to 4 (0 = *not at all* to 4 = *extremely*) indicating the degree of distress associated with each symptom in the past month. The PCL-5 possesses excellent psychometric properties in veteran samples (Bovin et al., 2015; Keane et al., 2014). In this study, reliability was excellent (Cronbach's alpha = .96).

Patient Health Questionnaire-9 (PHQ-9). Depressive symptoms were assessed using the nine-item self-report PRIME-MD Patient Health Questionnaire (PHQ-9; Kroenke, Spitzer, & Williams, 2001; Spitzer, Kroenke, & Williams, 1999). Respondents rate the degree to which they were bothered by symptoms during the past two weeks on a four-point scale ranging from 0 to 3 (0 = *not at all* to 3 = *nearly every day*). Items are summed to create a total score, with higher scores indicating greater symptom severity. In this study, the total score demonstrated strong internal consistency (Cronbach's alpha = .87).

Procedure

Participants completed self-report questionnaires online or by mail and were then interviewed via telephone by doctoral-level clinicians to determine PTSD and MDD diagnostic status on the SCID-5. All participants had completed Phase 1 of Project VALOR approximately 2.5 years prior to the current assessment. All participants provided informed consent prior to participation, and the study was approved by the local Institutional Review Boards and the Human Research Protection Office (HRPO) of the US Army Medical Research and Materiel Command.

Statistical Analysis

For the primary analyses, we randomly assigned our participants to one of two separate data sets, termed the *discovery* and *validation* subsamples, to evaluate the relationship between the most central symptoms as determined by network analyses, in their relationship to independent, clinician-rated PTSD and MDD diagnoses. Unless otherwise noted, analyses were performed in the combined sample of men and women. We first estimated network models of PTSD symptoms as reported on the PCL-5 in the discovery subsample using the least absolute shrinkage and selection operator (LASSO). Graphical LASSO networks are based on regularized partial correlations among all variables in which each edge (path) represents the association between two nodes (vari-

ables) independent from all other variables in the model (Epskamp & Fried, 2016; Friedman, Hastie, & Tibshirani, 2008). LASSO networks shrink coefficients while estimating networks, controlling for spurious associations and resulting in more parsimonious networks. The absence of paths in a graphical LASSO network suggests that two variables do not directly interact. We implemented the LASSO in the R package *qgraph* (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012), which uses the Extended Bayesian information criterion (EBIC) to select the best network by optimizing fit. We set the hyperparameter γ = 0.5, so that the EBIC would err on the side of parsimony.

Graphical LASSO networks are considered *weighted* graphs, with the partial correlations as weights signifying the magnitude of associations among variables. *qgraph* produces several types of useful output, including visual models. We used the Fruchterman–Reingold algorithm, in which the length of paths between nodes corresponds to the absolute edge weight, that is, the regularized partial correlation coefficient, to specify the layout of the nodes in the graph. Thus, nodes that are strongly associated with one another appear closer together in the graphs, allowing for inspection of the clustering among variables (Epskamp et al., 2012). Nodes with multiple strong associations will be located near the center of the graph, where the distance to other nodes is the shortest.

Qgraph also produces three main types of centrality indices for weighted graphs: betweenness, closeness, and strength. *Betweenness* is the degree to which a node lies on the shortest paths, based on weights (i.e., partial correlations in this study), between two other nodes and can be thought of as a measure of how much the node exerts control over information flow in the network (Opsahl, Agneessens, & Skvoretz, 2010). These are cross-sectional data, and accordingly, we conceptualize betweenness as reflecting the extent to which a variable connects to other variables. *Closeness* is the inverse of the mean shortest weighted path length (based on partial correlations) from a node to all other nodes; a high score indicates a short average distance to other nodes. *Strength* is the sum of weights of the paths connected to a node and reflects the degree of involvement of the node in the network (Opsahl et al., 2010). For all measures, higher scores are indicative of greater centrality.

Centrality indices are calculated based on the absolute values of edge weights. However, negative associations may exist within psychological networks, as increases in some symptoms may lead to decreases in other symptoms. The expected influence (EI) index has been developed to account for negative edge weights and is equal to the sum of weights between a node and all other nodes in the model (Robinaugh et al., 2016). If all edges are positive, the EI is equal to the node's strength.

Recent research has focused on evaluating the reliability of network model parameters, given that sample size can impact their accuracy and replicability. We used the new R package *bootnet* (Epskamp, Borsboom, & Fried, 2016) to construct confidence intervals (CIs) around edges in our network models as well as to determine the stability of our centrality indices. Nonparametric bootstrapping, with 1,000 draws, was used to approximate the CIs to assess variability of edge-weights. Overlapping edge-weight CIs indicate that the edge-weights do not differ from one another and that interpreting their order should be done with care.

Centrality stability was determined by subsetting the data and correlating the original centrality indices with those from the subsamples. This correlation is a stability coefficient used to determine the maximum number of cases that can be dropped without compromising the reliability of the centrality index. Epskamp and colleagues (2016) recommended that the order of nodes not be interpreted for centrality indices with stability coefficients <0.25, that is, a maximum of 25% of cases can be dropped without impacting the index's reliability. A stability coefficient of >0.5 is ideal, although the authors note that evidence for these guidelines is currently limited. For each of the models below, we present stability coefficients for centrality indices (betweenness, closeness, and strength) to guide our interpretation of the most central symptoms. In addition, we used the *differenceTest* function in *bootnet* to statistically compare centrality for pairs of variables by constructing bootstrapped CIs around the difference in strength scores.

We reasoned that, to the extent that the *ICD–11* PTSD symptoms emerged as the most central or most important to the overall PTSD network, this would provide support for the decision to limit the *ICD–11* PTSD diagnosis to these symptoms. Further, if these symptoms emerged as the most central, they would be expected to provide the most information about the other PTSD symptoms not included in the *ICD–11* proposal, reducing the potential for redundancy both within the PTSD diagnosis and across PTSD and comorbid conditions. This would ensure that even with elimination of other PTSD symptoms, the severity of these symptoms would still be represented by the diagnosis. On the other hand, to the extent that these symptoms were not the most important or central to the overall network, this would suggest that the *ICD–11* PTSD definition was missing key features of the disorder that reflect overall severity and caseness. We conducted several follow-up analyses to further evaluate whether the most central items versus the *ICD–11* items were more strongly associated with PTSD diagnoses. For each PCL-5 item, we created weights using strength scores (the most reliable centrality index, as described below) derived from the discovery sample. Next, for each of the six most central variables from the network analysis, we multiplied the item weight (strength score) with the item score and summed the weighted severity score across all six items. We also created an equivalent sum score for *ICD–11* symptoms as well as for six randomly selected symptoms. In the validation subsample, we used *t* tests to compare these weighted sum scores for participants with and without SCID PTSD diagnoses and calculated Cohen's *d* effect sizes to determine if the *ICD–11*, top six most central symptoms as identified in the discovery sample, or randomly selected symptoms better identified veterans with and without PTSD diagnoses. We also estimated logistic regression models with PTSD diagnoses as the outcome variable and the weighted sum scores as independent variables, respectively, to determine the extent to which these scores contributed to the variance in PTSD diagnoses. Of the 1,458 participants, a total of 1,377 completed the SCID-5 and were included in these analyses.

To explore the extent to which the symptoms in our graphs were potentially more reflective of comorbid MDD, we conducted several additional analyses. In the discovery subsample, we estimated graphical LASSO networks of PTSD (PCL-5) and MDD symptoms (PHQ-9) to visually inspect the closeness of the *ICD–11* symptoms to the MDD symptoms. We then selected participants with PTSD with and without SCID-5-based MDD diagnoses from the full sample and estimated the graphical LASSO networks in these two subsamples separately to determine whether symptom centrality differed among individuals in the different diagnostic groups. In the validation subsample, we first used *t* tests to compare the aforementioned weighted sum scores for participants with and without MDD diagnoses. We then calculated Cohen's *d* effect sizes to determine whether the *ICD–11*, six most central, or six randomly selected symptoms better discriminated people with and without MDD diagnoses. We also estimated logistic regression models with MDD diagnosis as the outcome variable and the weighted sum scores as independent variables, respectively, to determine the extent to which these scores contributed to the variance in MDD diagnosis.

Results

Trauma Exposure

Participants endorsed a range of trauma exposure types on the LEC-5. The majority (86.7%) reported exposure to combat; 57.9% reported being physically assaulted, and 41.7% reported a history of sexual trauma, including sexual assault or harassment. Other frequently endorsed traumas included transportation accidents (55.4%) and unexpected death of a loved one (45.3%). The majority of participants (87.4%) reported that their worst trauma occurred during their military service. By design, the majority (62.9%) met *DSM–5* criteria for PTSD; 24.1% met *DSM–5* criteria for MDD.

Graphical LASSO Network: PCL-5 Items

The graphical LASSO network, estimated in the discovery subsample, is presented in Figure 1 in the online supplemental material. Nodes that are more highly associated with one another appear physically closer in the graph. Green lines represent positive associations, and red lines represent negative associations; the thickness of the line indicates the magnitude of a given partial correlation. Symptoms and abbreviations, as well as rankings for centrality measures, are presented in Table 1. Generally, there were strong, positive associations among symptoms within each cluster; thus, in the graphs, symptoms tended to cluster closely together with other symptoms in their *DSM–5* criterion set, particularly the intrusion and the negative alterations in cognitions and mood symptoms, with the exception of inability to recall features of the trauma (Symptom D1). In addition, irritable behavior and self-destructive or reckless behavior were less connected to other arousal and reactivity symptoms. Problems with concentration, self-destructive or reckless behavior, distressing dreams, diminished interest in activities, persistent negative emotional state, and exaggerated startle response were the top six symptoms on betweenness, indicating that they acted as connectors among the variables in the network. Self-destructive or reckless behavior, distressing dreams, problems with concentration, intrusive distressing thoughts or memories, diminished interest in activities, and sleep disturbance had the highest scores on the closeness statistic, indicating they had the shortest average distances to the other variables (based on regularized partial correlations). Persistent negative emotional state, efforts to avoid external reminders,

efforts to avoid thoughts or memories, inability to experience positive emotions, distressing dreams, and intrusive distressing thoughts or memories had the highest strength scores; these variables were the most involved in the network.

The stability coefficients for betweenness (0.206), closeness (0.128), and strength (0.439) indicated that only the strength index could be reliably used to rank symptoms. We also calculated the EI of all symptoms to determine which had the highest expected influence in the network. The six items with the highest EI scores were persistent negative emotional state, efforts to avoid external reminders, efforts to avoid thoughts or memories, inability to experience positive emotions, intrusive distressing thoughts or memories, and psychological distress. Notably, five out of the top six symptoms overlapped for strength and EI. We, therefore, used items with the highest strength scores as our "top six" PTSD symptoms. Of these, efforts to avoid external reminders, efforts to avoid thoughts or memories, and distressing dreams are proposed for inclusion in the *ICD–11*.

In addition to investigating the stability of our centrality indices, we used nonparametric bootstrapping to calculate CIs around our edge weights. Results revealed overlapping CIs for most edge weights, indicating that their order should be interpreted with care. The edges between efforts to avoid external reminders and efforts to avoid thoughts or memories, hypervigilance and exaggerated startle response, and intrusive distressing thoughts or memories and distressing dreams were the strongest and overlapped with few other edges (see figure 2 in the online supplemental material).

We also constructed a plot to determine whether strength differed significantly among PTSD symptoms. As shown in Figure 1, many variables did not differ in terms of strength. Further, there were few significant differences between our top six and *ICD–11* items: inability to experience positive emotions, efforts to avoid

external reminders and efforts to avoid thoughts or memories all had significantly higher strength scores than did dissociative flashbacks.

Graphical LASSO Networks: PCL-5 and PHQ-9 Items

The graphical LASSO network for the PCL-5 and PHQ-9 items, estimated in the discovery subsample, is presented in Figure 3 in the online supplemental material. The items from each measure tended to cluster within their respective measures, demonstrating fairly good distinction of the two constructs. Not surprisingly, there were strong, positive associations between bridge symptoms shared by both disorders, that is, problems concentrating, diminished interest in activities, and sleep disturbance, which accounted for most of the linkage between disorders. The stability coefficients for betweenness (0.284), closeness (0.361), and strength (0.361) indicated that all three indices may be reliably used to rank symptoms. Problems with concentration (PTSD) had high scores on all three indices. Anhedonia (MDD), distressing dreams (PTSD), problems with concentration (MDD), and sleep disturbance (PTSD) had high betweenness and closeness scores. Sleep disturbance (MDD), persistent negative emotional state (PTSD), feeling down or depressed (MDD), intrusive distressing thoughts or memories (PTSD), and efforts to avoid external reminders (PTSD) had the highest strength scores.

To numerically evaluate the strength of associations between the top six most central items (from the PCL-5 graph), the *ICD–11* items, and the PHQ-9 items, we summed the regularized partial correlations from the graphical LASSO between the top six items and PHQ-9 items and took the average of this value to derive an average association of 0.006. We computed this average association for the *ICD–11* symptoms as well; this value was 0.0007.

Table 1

PTSD Symptoms, Abbreviations, and Ranking on Measures of Strength Centrality

DSM–5 symptom cluster and number	DSM–5 symptoms	Abbreviation	Discovery sample	PTSD − MDD	PTSD + MDD
B1	Intrusive distressing thoughts or memories	Mem	X	X	X
B2	Distressing dreams[a]	Drm	X		
B3	Dissociative flashbacks[a]	Fls			X
B4	Psychological distress	Ups		X	X
B5	Physiological reactions	Phy			
C1	Efforts to avoid thoughts/memories[a]	Avm	X	X	
C2	Efforts to avoid external reminders[a]	Avx	X		
D1	Inability to recall features of the trauma	Amn			
D2	Negative beliefs	Blf			
D3	Distorted blaming of oneself or others	Blm			
D4	Persistent negative emotional state	Neg	X	X	X
D5	Diminished interest in activities	Anh			X
D6	Detachment from others	Cut			
D7	Inability to experience positive emotions	Pos	X	X	X
E1	Irritable behavior	Irr			
E2	Self-destructive or reckless behavior	Rsk			
E3	Hypervigilance[a]	Hyp		X	X
E4	Exaggerated startle response[a]	Str			
E5	Problems with concentration	Cnc			
E6	Sleep disturbance	Slp			

Note. Results are presented for the full sample. PTSD = posttraumatic stress disorder; *DSM–5* = *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.); MDD = major depressive disorder; PTSD − MDD = subgroup of participants who met criteria for PTSD but not MDD; PTSD + MDD = subgroup of participants who met criteria for PTSD and MDD; X = symptom was in the top 6 items on a given centrality measure.
[a] Symptoms proposed for inclusion in the *International Classification of Disease—11*.
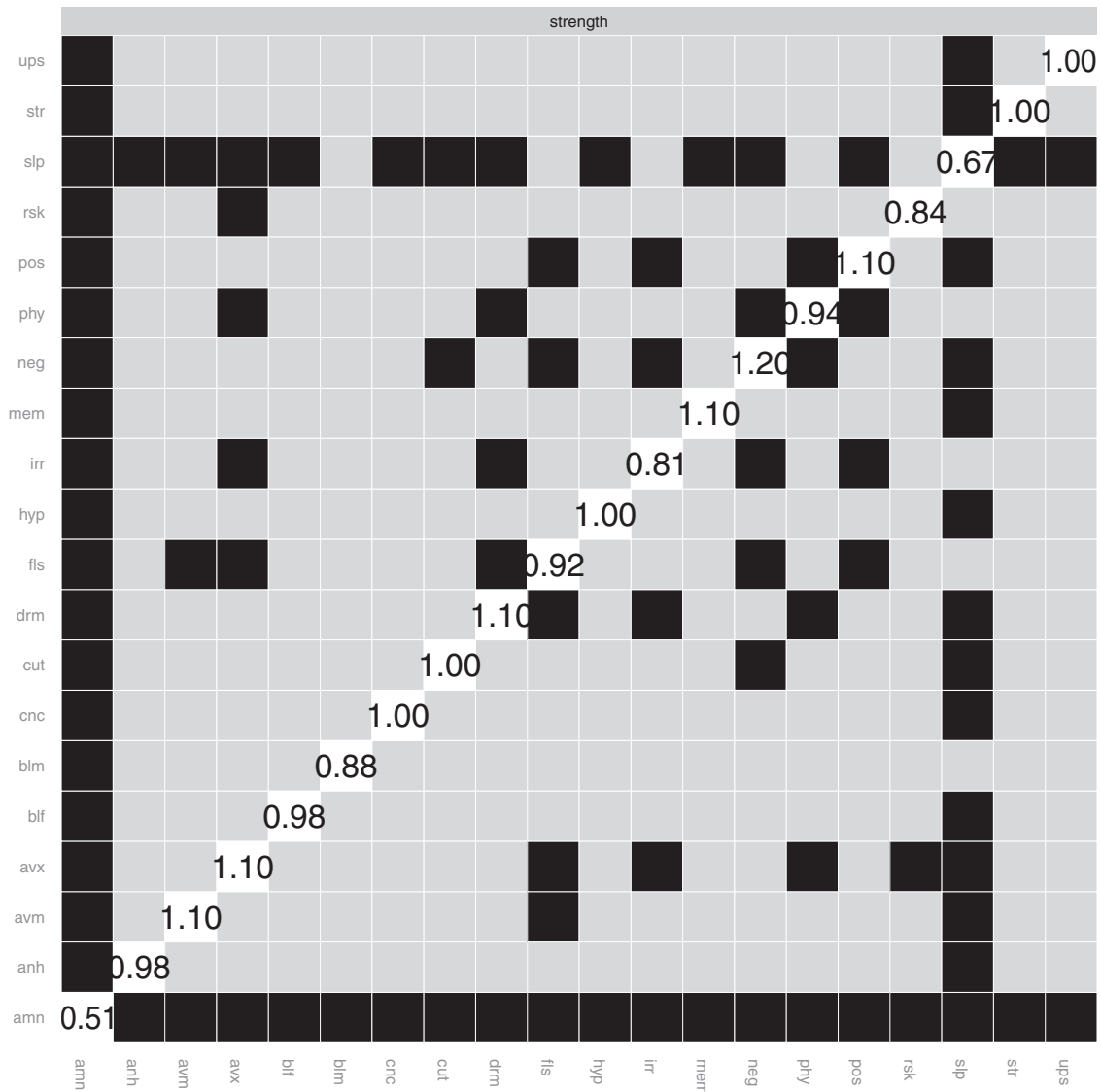
Figure 1. Differences in strength between PTSD symptoms in the graphical LASSO network. Bootstrapped difference tests between node strength for all PTSD symptoms in the discovery sample. Values in the white boxes are node strength scores. Gray boxes are nodes that do not differ significantly from one another; black boxes represent nodes that do differ significantly from one another. PTSD = posttraumatic stress disorder; mem = intrusive distressing thoughts or memories; drm = distressing dreams; fls = dissociative flashbacks; ups = psychological distress; phy = physiological reactivity; avm = efforts to avoid thoughts or memories; avx = efforts to avoid external reminders; amn = inability to recall features of the trauma; blf = negative beliefs; blm = distorted blaming of oneself or others; neg = persistent negative emotional state; anh = diminished interest in activities; cut = detachment from others; pos = inability to feel positive emotions; irr = irritable behavior; rsk = self-destructive or reckless behavior; hyp = hypervigilance; str = exaggerated startle response; conc = problems with concentration; slp=sleep disturbance.

Thus, the difference between the two symptom sets was less than 1% in terms of variance accounted for, suggesting that their associations with MDD did not differ meaningfully.

PTSD ± Depression

To further investigate the extent to which comorbid MDD symptoms influenced our network analysis results, we estimated the graphical LASSO models for the PCL-5 among subsamples of participants (from the full sample) with SCID-5 PTSD diagnoses, with ($n = 516$) and without ($n = 299$) SCID-5 MDD diagnoses. For both subsamples, the stability coefficients indicated that only the strength index could be reliably used to rank symptoms. Among participants with PTSD only, the six symptoms with the highest strength scores were persistent negative emotional state,

intrusive distressing thoughts or memories, hypervigilance, psychological distress, inability to experience positive emotions, and efforts to avoid external reminders (i.e., two *ICD–11* criteria made this list). In contrast, among participants with PTSD and MDD, the top six symptoms were psychological distress, persistent negative emotional state, hypervigilance, intrusive distressing thoughts or memories, diminished interest in activities, and dissociative flashbacks (i.e., two *ICD–11* criteria made this list). Thus, the most central variables among both groups of participants included a mix of putative PTSD-specific symptoms and symptoms shared between the two disorders.

Comparison of Network Model Results With PTSD Diagnoses

We estimated correlations between the six most central variables from the PCL-5 graph suggested by our analyses in the discovery sample, the six *ICD–11* variables, and six randomly selected variables (i.e., detachment from others, distorted blaming of oneself or others, inability to recall features of the trauma, physiological reactions, self-destructive or reckless behavior, and intrusive distressing thoughts or memories) and total PCL scores in the validation subsample. The top six, $r = .959$, $p < .001$, *ICD–11*, $r = .930$, $p < .001$, and random six, $r = .969$, $p < .001$ symptoms were highly, significantly associated with PCL scores. We then created weighted[1] scores of the six most central variables, the six *ICD–11* variables, and six randomly selected variables by multiplying each variable by its strength score, then summing across the six weighted variables. We then compared mean values on these weighted sum scores for participants with and without SCID-5 PTSD diagnoses in the validation subsample to test if these different criteria sets were differentially associated with independently assessed PTSD diagnoses. All *t* test results were significant, such that participants with PTSD consistently had higher mean scores than those without PTSD (see Table 2). Further, Cohen's *d* effect sizes were quite similar for the top six ($d = 1.37$), *ICD–11* ($d = 1.31$), and random six ($d = 1.30$) sum scores.

We also estimated logistic regression models for each of the three weighted sum scores, respectively, with SCID-5-based PTSD diagnoses as the dependent variable, to determine the percent variance in diagnosis accounted for by the sum scores. Nagelkerke's R^2 for each sum score was: 0.404 (top six), 0.379 (*ICD–11*), and 0.380 (random six). The 95% confidence intervals (CIs) for each odds ratio (*OR*) overlapped with one another: top six (*OR* = 1.223, 95% CI [1.184, 1.262]), *ICD–11* (1.213, 95% CI [1.176, 1.252]), random six (*OR* = 1.300, 95% CI [1.245, 1.357]). These results suggest that associations between each weighted sum score and PTSD diagnosis did not differ significantly from each other.

Comparison of Network Model Results With MDD Diagnoses

We then compared mean values on the three weighted[1] sum scores for participants with and without SCID MDD diagnoses. As shown in Table 2, all *t* tests were significant, such that participants with MDD consistently had higher mean scores than those without MDD. Cohen's *d* effect sizes were similar for the top six ($d = 0.747$), *ICD–11* ($d = 0.622$), and random six ($d = 0.873$) sum scores.

Finally, we estimated logistic regression models for each of the three weighted sum scores, with SCID MDD diagnosis as the dependent variable. Nagelkerke's R^2 for each sum score was: 0.137 (top six), 0.101 (*ICD–11*), and 0.179 (random six). In comparing the odds ratios for the three symptom sets, the 95% CIs differed significantly for the *ICD–11* (*OR* = 1.093, 95% CI [1.063, 1.123]) and random six (*OR* = 1.175, 95% CI [1.131, 1.220]) symptom scores, but were overlapping between the *ICD–11* and top six scores (*OR* = 1.109, 95% CI [1.079, 1.140]), and between the random six and top six symptom scores.

Comparison of Graphs by Sex

There were both similarities and differences in the top six items from the PTSD network (see figure 4 in the online supplemental material) when estimated separately among women ($n = 375$) and men ($n = 354$) in the discovery sample. The stability coefficients indicated that only the strength index could be reliably used to rank symptoms in both subsamples. Persistent negative emotional state, inability to experience positive emotions, efforts to avoid external reminders, and intrusive distressing thoughts or memories were in the top six symptoms for both sexes (see table 1 in the online supplemental material). Among women, the additional two items with the highest centrality scores were hypervigilance and diminished interest in activities. Among men, the additional top two items were distressing dreams and problems concentrating.

When examining graphs separately for women ($n = 260$) and men ($n = 256$) with PTSD only, persistent negative emotional state, intrusive distressing thoughts or memories, and hypervigilance appeared in the top six symptoms in both subgroups. Inability to experience positive emotions, physiological distress, and efforts to avoid thoughts or memories appeared more central for women, whereas detachment from others, efforts to avoid external reminders, and psychological distress were more salient for men. Similarly, only dissociative flashbacks and psychological distress were in the top six symptoms for both women ($n = 253$) and men ($n = 146$) with PTSD and MDD. It should be noted, however, that none of the stability coefficients reached the minimum acceptable level of 0.25 proposed by Epskamp and colleagues (2016) among women with PTSD and MDD or among men with PTSD only, implying that interpretation of these results should be done with caution. The strength index had the highest coefficient among men with PTSD only (0.207), and strength and closeness tied for highest among women with PTSD and MDD (0.131).

Discussion

To our knowledge, this is the first network analysis of *DSM–5* PTSD symptoms. The most central PTSD symptoms were persistent negative emotional state, efforts to avoid external reminders, efforts to avoid thoughts or memories, inability to experience positive emotions, distressing dreams, and intrusive distressing thoughts or memories. Inability to experience positive emotions and persistent negative emotional state could be present in many other disorders including MDD. When we estimated our network

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[1] The pattern of results for the *t* tests, Cohen's *d,* and logistic regression models was very similar when using raw sum scores compared to the weighted sum scores.

Table 2
t Test Results Comparing Weighted Sum Scores by PTSD and MDD Diagnosis

	PTSD+		PTSD−				MDD+		MDD−			
	M	SD	M	SD	t	p	M	SD	M	SD	t	p
Top six symptoms	16.572	5.924	7.990	6.589	−16.695	<.001	17.054	6.489	11.872	7.349	−8.535	<.001
ICD–11 symptoms	15.895	5.797	7.773	6.546	−15.951	<.001	15.907	6.677	11.605	7.141	−7.032	<.001
Random six symptoms	12.288	4.550	6.144	4.891	−16.220	<.001	13.205	4.790	8.770	5.357	−9.477	<.001

Note. The top six symptoms were persistent negative emotional state, efforts to avoid external reminders, efforts to avoid thoughts or memories, inability to experience positive emotions, distressing dreams, and intrusive distressing thoughts or memories. The symptoms proposed for inclusion in the *International Classification of Disease—11* (*ICD–11*) are distressing dreams, dissociative reactions, efforts to avoid thoughts/memories, efforts to avoid external reminders, hypervigilance, and exaggerated startle response. The random six symptoms were detachment from others, distorted blaming of oneself or others, inability to recall features of the trauma, physiological reactions, self-destructive or reckless behavior, and intrusive distressing memories. Weighted sum scores for each of the three groups of symptoms were created by multiplying each item score by their strength scores, then summing the six weighted variables. PTSD = posttraumatic stress disorder; PTSD+ = participants with PTSD diagnoses; PTSD− = participants without PTSD diagnoses; MDD = major depressive disorder; MDD+ = participants with MDD diagnoses; MDD− = participants without MDD diagnoses.

model of PTSD symptoms in participants with PTSD but not MDD, persistent negative emotional state, intrusive distressing thoughts or memories, inability to experience positive emotions, and efforts to avoid external reminders remained among the most central symptoms, along with psychological distress, and hypervigilance. Taken together, our results suggest that the putatively PTSD-specific symptoms that are most central to this network are efforts to avoid external reminders, efforts to avoid thoughts or memories, distressing dreams, intrusive distressing thoughts or memories, psychological distress (in response to trauma reminders), and hypervigilance. That said, symptoms that are thought to overlap with depression (persistent negative emotional state and inability to experience positive emotions) were also central to those with PTSD without MDD, suggesting that eliminating them from the *ICD–11* PTSD diagnosis might have the unintended consequence of failing to identify "pure" cases of PTSD (at least with respect to comorbid MDD).

Symptom nonspecificity has long been an issue in defining PTSD, as many PTSD symptoms overlap with other mental health disorders, including mood and anxiety disorders (Spitzer et al., 2007), although this is a problem inherent to many *DSM* diagnoses, not just PTSD (Byllesby et al., 2016; Watson, 2005; Zbozinek et al., 2012). Our findings indicate that some of these nonspecific symptoms are important to the PTSD network. However, it is worth noting that network analyses are only as good as their input data. That is, we defined our network using the 20 *DSM–5* symptoms, the diagnostic system currently recognized in the PTSD field. We therefore began with the assumption that all these symptoms have the potential to provide value in defining the PTSD construct, an issue that continues to be under debate since the publication of *DSM–5* (Friedman, Kilpatrick, Schnurr, & Weathers, 2016; Hoge et al., 2016). These results cannot determine whether one set of criteria is more correct than another. However, we can test to some extent if, given existing criteria, eliminating some of them might lose valuable information. Phenotype refinement is important because the search for the biomarkers, correlates, and interventions to treat PTSD will be hampered if the phenotype is not psychometrically sophisticated and externally valid. Our results may represent an initial effort to evaluate the proposed PTSD phenotype and shed light on its potential refinement. To meet the goals of improving diagnostic utility and reducing psychiatric comorbidity, the *ICD–11* PTSD working

group's intention was to select symptoms that are specific to PTSD and not shared with other disorders. However, of the proposed *ICD–11* symptoms, only efforts to avoid external reminders, efforts to avoid thoughts or memories, and distressing dreams were among the top six symptoms in the network. This suggests that the three other proposed *ICD–11* symptoms may not be the most central to the *DSM–5* PTSD network and that potentially critical information from the most central symptoms not included in the *ICD–11* proposal may be lost if that proposal is advanced.

Network model results alone cannot fully address whether the nonspecific symptoms should be excluded due to their limited discriminant validity, which is the very argument that the *ICD–11* committee made for excluding these symptoms. To remedy this limitation, we also estimated a model of PTSD and MDD symptoms and found, as predicted, that their shared symptoms acted as bridge symptoms among the two disorders. However, network models of both PTSD and MDD showed relative distinction between the two criterion sets, providing us with additional confidence that the majority of the symptoms that were the most central in our analyses had relatively low overlap across diagnoses.

Two aspects of our results underscore the need to interpret these findings with caution. First, although stability coefficients suggested that our strength indices met the proposed minimally acceptable criteria for interpretation, we found very few significant differences in strength between our top six symptoms and the *ICD–11* symptoms. Second, we found negligible differences in effect size when comparing indices (weighted mean sum scores) of the top six items, six *ICD–11* items, and a random selection of six symptoms between participants with and without PTSD diagnoses. Importantly, *ICD–11* symptoms do not appear to discriminate individuals with and without PTSD better than the top 6 symptoms or the randomly selected symptom set, suggesting that these symptoms may not meet the working group's stated goal of improving diagnostic utility (Maercker et al., 2013). Ideally, a reduced set of PTSD symptoms would be substantially more predictive of PTSD diagnoses than sets of symptoms not included in the reduced set. In addition, the *ICD–11* and top six symptoms appeared similarly associated with MDD diagnoses, even though one would expect that the *ICD–11* symptoms, none of which is a criterion for MDD (by design of the *ICD–11* workgroup), would be less related to depression. Further, these findings are consistent with those of Wisco and colleagues (2016), who found that the *ICD–11* defini-

tion of PTSD was no less associated with psychiatric comorbidity than was *DSM–IV* PTSD.

Our results regarding the most central PTSD symptoms for men and women have implications for *ICD–11* as well. Distressing dreams and problems concentrating were particularly central among men in this study, underscoring the potential usefulness of these symptoms as treatment targets. In contrast, hypervigilance and diminished interest in activities were more central for women. The literature is mixed regarding endorsement of specific PTSD symptoms in men versus women (Carmassi et al., 2014; King, Street, Gradus, Vogt, & Resick, 2013; Maguen, Luxton, Skopp, & Madden, 2012). However, our results are consistent with previous findings that anhedonia in PTSD is more prevalent among women and the suggestion that reward functioning deficits observed in PTSD may differ by sex. Specifically, it has been suggested that women have a stronger bias toward negative stimuli under stress, and thus are more likely to focus on loss avoidance, whereas men have greater reward sensitivity and approach motivation (Carmassi et al., 2014; Nawijn et al., 2015). The *DSM–5* includes a broader range of symptoms than does *ICD–11*, implying that despite sex-related differences in centrality, the symptoms most central to men and women would both be captured by the *DSM–5* diagnosis. In contrast, the narrow *ICD–11* symptom set could systematically bias the construct and diagnosis so that it was less applicable to one sex, as there are very few symptoms included in the diagnostic criteria to function as a safety net to capture symptom presentations that may differ across sex and other demographic or trauma groups. Greater consideration and research is required to evaluate if the *ICD–11* symptom set may be more or less applicable to certain groups of individuals.

In the only other available network analysis of PTSD symptoms, McNally and colleagues (2015) found that difficulty concentrating, hypervigilance, distressing dreams and sleep disturbance were highly central to their network of *DSM–IV* PTSD symptoms. Of these, only difficulty concentrating and distressing dreams were among our most central symptoms. Although both studies used the PCL, they were based on different versions of the *DSM*, and the samples were quite different - McNally and colleagues' sample included Chinese adult survivors of a major earthquake. Therefore, the differences in findings could be due to the network topology of PTSD differing by trauma type, the existence of multiple network structures of PTSD, or subtle differences in analytic approaches due to the advancement of network modeling over time, which are reflected in the differences reported in our respective studies. Regardless of the reason for the discrepancy, these differences underscore the importance of replication across a range of samples. As well, to the extent that there are differences in network structure across populations, this would suggest that it might be best to rely on an overly inclusive criteria set relative to an overly restrictive one as the former has a built-in safeguard that would identify individuals with PTSD even when the most central symptoms differ across the populations, whereas the latter would risk missing PTSD in some populations or being otherwise biased as a function of population characteristics.

In addition to the need for replication, several limitations should be noted. Data from this study are based on a self-report measure of PTSD, the PCL-5. The PCL-5 does not require responses to be linked to a specific traumatic event; rather, instructions ask participants to indicate how often they have experienced symptoms that people sometimes have in response to a very stressful experience. Although SCID-5 data were available, the use of skip-outs in the SCID-5 makes these data less than ideal for analysis in network models, which is why we used the SCID-5 data only to index PTSD diagnosis. Data from this study were cross-sectional; future studies will need to investigate associations among PTSD symptoms over time. In addition, the use of a sample of male and female veterans who have very high rates of combat trauma may not generalize to other trauma-exposed populations. Nonetheless, this study has several major strengths, including the large sub-samples of women and men. Female veterans remain understudied, and many samples are not large enough to evaluate sex differences.

Relative to the *DSM–5* PTSD criteria, the *ICD–11* definition of PTSD has consistently produced lower PTSD diagnostic rates in prior studies (Hansen et al., 2015; Wisco et al., 2016). Given that the *ICD–11* will presumably be used for billing and reimbursement in the US, the lack of interchangeability across the two systems may pose a significant problem in clinical practice. The goals of the *ICD–11* are to improve diagnostic utility and reduce psychiatric comorbidity. Our findings, and those from previous studies (e.g., Wisco et al., 2016) raise doubts about the extent to which these aims have been achieved using the proposed limited symptom set. We recommend that future studies explore alternate definitions of PTSD that strike a better balance of identifying a consistent group of individuals with the diagnosis and allowing for greater parsimony, ease of assessment, and diagnostic specificity. As noted above, network model results alone likely cannot tell us how best to diagnose a disorder or what guiding principles should be prioritized as the network is limited by the extant set of criteria for a disorder and is agnostic about the broader aims of the diagnostic taxonomy. Further, it is important to determine whether the most central symptoms provide information about other symptoms in the network or are highly representative of those with a given diagnosis, as these results may be worth considering in determining how to best assess the PTSD construct. Results of network analysis using longitudinal data could be used to identify the symptoms that most strongly influence other symptoms and to assess whether these variables are strong candidates for a reduced set of PTSD criteria that does not lose substantial information or exclude patients who should be classified as having the disorder.

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